

mosaics

n°1



deterioration and conservation rome november 1977



ICCROM

mosaics

n°1

deterioration and conservation rome november 1977

This report was published by the International Centre for the Study of the Preservation and the Restoration of Cultural Property, (ICCROM), 13 Via di San Michele, Rome.
The layout was done by Véronique Demaret.
Forrest Selvig edited this English edition.

ACKNOWLEDGMENTS

This volume contains the proceedings of the First International Symposium on the Conservation of Mosaics which was held in Rome from 2 to 5 November 1977. It was produced by the collaboration of the following persons:

Patricia Bonicatti
Véronique Demaret
Gaël de Guichen
Susan Inman
Patricia Johnson
Cynthia Rockwell
Forrest Selvig

The Symposium was made possible by grants generously given by UNESCO, the Direction des Musées de France and the Goethe-Institut.

On behalf of all the participants, we would like to express our sincere gratitude to all those who made this symposium possible.

ICCROM

FOREWORD

As an inter-governmental organization entrusted with the conservation and restoration of cultural property, ICCROM is happy to have conceived and organized this First International Symposium on the Conservation of Mosaics. Indeed, in almost every country that was formerly part of the ancient Roman world, wall or pavement mosaics are often poorly maintained after their discovery. This leads to the rapid disappearance of unique parts of our patrimony.

Awareness of this problem is necessary at all levels:

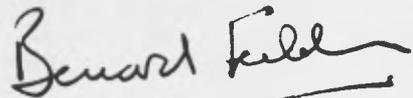
on the technical level so that conservators share their experiences and criticize and improve, if necessary, older methods and techniques;

among archaeologists so that they recognize that a newly discovered mosaic is a mosaic in danger and that their duty toward it does not end with scholarly study and publication. Conservation is surely one of the archaeologist's duties. Though it may be difficult, it is no less imperative;

among administrators who must understand the importance of this patrimony, be interested in it, and budget adequately for its conservation;

on the public level so that specialists responsible for conservation receive support from both groups and individuals. It is the public, after all, that benefits and is served by the world-wide conservation movement.

We dare hope that each participant, upon returning to his own country, will work to spread the ideas that have been exchanged at this meeting, and that, in this way, the mosaics discovered will be transmitted intact to future generations.



Bernard M. Feilden,
Director, ICCROM
1 September 1978

Sources of illustrations

All photographs were furnished by the authors of the respective papers except for the following: paper by Irina Andreescu, 1, plate, Archivio di Stato, Venice, 2 and 11, plates, Dietmar Saretz, 3-8, plates, Soprintendenza ai Monumenti, Trieste, 9, plate, Collection Chrétienne et Byzantine, Ecole Pratique des Hautes Etudes, Paris, 10,

plate, E. Ritter, 12, Dietz-Demus, Byzantine Mosaics, fig 67, 13 and 16, plates, M. Skiadaresis, 14 and 15, Ecole Pratique des Hautes Etudes, Paris, from Dietz-Demus, *op. cit.*, figs. 89-90; paper by Paul Philippot, photographs furnished by Gaël de Guichen; paper by Ciro Robotti, and cover, Archivio, Soprintendenza Archeologica di Ostia.

LIST OF PARTICIPANTS

- Maria Luisa Abreu Nunes
Conservation technician,
Museu Nacional de Arqueologia e Etnologia,
R. Tenente Ferreira Durao, 55 - 3 Esq.,
Lisbon, Portugal
- Margaret Alexander
Professor and Co-Director,
Corpus of the Mosaics of Tunis,
Department of Classics,
University of Iowa,
Iowa City, Iowa 52242, U.S.A.
- Irina Andreescu
Assistant Professor of Byzantine Archaeology,
Center for Byzantine Studies,
Dumbarton Oaks,
1703 Thirty-second Street N.W.,
Washington, D.C. 20007, U.S.A.
- Elisabetta Anselmi
Restorer,
Istituto Centrale del Restauro,
Piazza San Francesco di Paola 9,
00186 Rome, Italy
- Vincenzo Antonelli
Soprintendenza Beni Ambientali
ed Architettonici di Venezia,
Palazzo Ducale,
Venice, Italy
- Claude Bassier
Restorer,
Sauvetage Archéologique,
SOCRA, Quartier des Usines du Toulon,
24000 Perigueux, France
- Luisa Bertacchi
Director,
Museo Archeologico Nazionale,
Via Roma 1,
Aquileia (Udine), Italy
- Malika Boutira
Direction des Beaux Arts,
119 rue Didouche Mourane,
Algiers, Algeria
- Gianfranco Bustacchini
Restorer,
Accademia di Belle Arti,
Ravenna, Italy
- Paolo Cozzi
Restorer,
Opificio delle Pietre Dure,
Via degli Alfani 78,
50121 Florence, Italy

- Anne Destrooper
Archaeologist,
Université Catholique de Louvain,
C/o Anna Kabanopoulou,
Voulgaroktonou - Franzi, 14,
Athens 708, Greece
- Edith Dietze
Anthropology Conservation Laboratory,
NHB Room 361, Smithsonian Institution,
Washington, D.C. 20560, U.S.A.
- Mongi Ennaifer
Curator,
Musée du Bardo,
and Director, Corpus des Mosaïques de Tunisie,
Musée du Bardo,
Le Bardo, Tunisia
- Jeronimo Escalera Urena
Restorer,
Chief of the Mosaics Department,
Istituto de Conservacion y Restauracion
de Obras de Arte,
Palacio de America,
Avenida Reyes Catolicos,
Madrid 3, Spain
- Andreas Farmakas
Restorer,
Department of Antiquities,
Nicosia, Cyprus
- Elizabeth Figueiredo Cabral
Restorer,
Museu Nacional de Arqueologia e Ethnologia,
Rua Sousa Pinto n. 12, 1 Dto,
Monte Abraao,
Queluz, Portugal
- Piero Frizzi
Restorer,
Opificio delle Pietre Dure,
Via degli Alfani 78,
50121 Florence, Italy
- Francisco Gago Blanco
Restorer,
Museo Arqueologico Nacional
Vinaroz 36, 1 D,
Madrid 2, Spain
- Michal Gamzou
Hamarganit Street, 22,
Ramat-Gan, Israel
- Andreas Georgiades
Chief Conservator,
Numismatic Collection,
National Archaeological Museum,
Tositsa 1,
Athens 147, Greece
- Mohammed Ghouj
Restorer,
Department of Antiquities,
Amman, Jordan
- René Guilly
Conservateur Chargé du Service de Restauration
des Musées Classés et Controlés,
Palais du Louvre,
Paris, France 75041
- Bogdan Kovacevic
Painter - Curator,
Institute for the Protection
of Cultural Monuments,
21000 Novi Sad,
Strosmajerova 22, Yugoslavia

Jean-Louis Laffont	2ter rue Alsace Lorraine, 31000 Toulouse, France
Henri Lavagne	12, rue de l'Université, 75007 Paris, France
Eliane Lenoir	Co-Director, Chantier d'Ad Mercuri (Morocco), Ecole Française, Palazzo Farnese, Piazza Farnese, 00186 Rome, Italy
Maurice Lenoir	Ecole Française, Palazzo Farnese, Piazza Farnese, 00186 Rome, Italy
Lawrence Majewski	Professor, Conservation Center of The Institute of Fine Arts, New York University, 1 East 78th Street, New York, New York 10021, U.S.A.
Fabrizio Mancinelli	Curator, Department of Medieval and Modern Art, Direction General of the Vatican Museums, Vatican City
Giuseppe Marinelli	CIBA-Geigy S.p.A., Casella Postale 88, 21047 Saronno (Va.), Italy
Jagoda Meder	Art Historian, Curator of Monuments, Republicki Zavod za Zastitu Spomenika Kulture, 41000 Zagreb, Livadiceva 1, Yugoslavia
Johanan Mintzker	Director, Sub-Department of Conservation, Department of Antiquities, P.O. Box 586, Jerusalem, Israel
Laura Sbordoni Mora Paolo Mora	Chief Restorer, Istituto Centrale del Restauro, Piazza San Francesco di Paola 9, 00186 Rome, Italy
Mara Nimmo	Restorer, Istituto Centrale del Restauro, Piazza San Francesco di Paola 9, 00186 Rome, Italy
William Edward Novis	Private Consultant, Batchelors, Barns Green Horsham, England RH 13 7QB
Elio Papparatti	Restorer, Soprintendenza Archeologica Roma - Foro Romano, Via Arco de' Cenci 1, 00186 Rome, Italy
Ciro Piccioli	Soprintendenza Archeologica, Piazza Museo 18, Naples, Italy

- Peter Popov
Artist-Painter,
Department of Conservation and Restoration
of Cultural Property,
National Institute for Historical Monuments,
44, boulevard Dondoukov,
Sofia, Bulgaria
- Ciro Robotti
Architect,
University of Naples,
Via A. Diaz 7,
80055 Portici (Napoli), Italy
- H. Roosens
Director,
Service National des Fouilles,
Ministère de l'Education Nationale
et de la Culture,
Parc du Cinquanteaire 1,
B - 1040 Brussels, Belgium
- Amy Rosenberg
Assistant Curator in Conservation,
Kelsey Museum,
The University of Michigan,
434 South State Street,
Ann Arbor, Michigan 48104, U.S.A.
- Raffaella Rossi Manaresi
Scientific Officer,
Centro per la Conservazione
delle Sculture all'Aperto,
Via de' Pignattari 1,
40124 Bologna, Italy
- Abdallah Sail
Direction des Beaux Arts,
119 rue Didouche Mourane,
Algiers, Algeria
- Romano Serena
Soprintendenza Beni Ambientali
ed Architettonici di Venezia,
Palazzo Ducale,
Venice, Italy
- Marcel Stefanaggi
Chief of Laboratory,
Laboratoire de Recherche des Monuments
Historiques,
77420 Château de Champs-sur-Marne, France
- Giovanni Urbani
Director,
Istituto Centrale del Restauro,
Piazza San Francesco di Paola 9,
00186 Rome, Italy
- Maria Luisa Veloccia
Superintendent,
Soprintendenza alle Antichità del Lazio,
Piazza delle Finanze 1,
00185 Rome, Italy
- Rosalia Varoli
Art Historian,
Istituto Centrale del Restauro,
Piazza San Francesco di Paola 9,
00186 Rome, Italy
- Catherine Vernooj
Gabriel Metsustraat 16,
Amsterdam, Holland
- Bianca Vicentini
Opificio delle Pietre Dure,
Via degli Alfani 78,
50121 Florence, Italy

Alberto Villa

CIBA-Geigy S.p.A.,
Casella Postale 88,
21047 Saronno (Va.), Italy

Jan Voskuil

Editor of Publications/Restorer,
Central Research Laboratory,
Gabriel Metsustraat 8,
Amsterdam, Holland

Rolf Wihr

Restorer,
Bayer. Landesamt für Denkmalpflege
Aussenstelle Bamberg - Schloss Seehof,
8602 Memmelsdorf b. Bamberg,
Federal Republic of Germany

M. Yankelovich

Archaeologist,
Via Maria Cristina 2,
00196 Rome, Italy

ICCROM Staff

Participants

Bernard Feilden
Paul Schwartzbaum
Giorgio Torraca

Organization

Patricia Bonicatti
Gaël de Guichen
Pia Pierre
Vickii Richardson
Cynthia Rockwell

GLOSSARY

- Arriccio** - The preliminary plaster layer spread on masonry walls. It is left rough so that the final top layer, *intonaco*, will adhere more easily. Also known as *scratch coat*.
- Bema** - A raised stage for the clergy in the apse of Early Christian churches.
- Buon fresco** - The decoration of walls and ceilings with pigments mixed with water and painted upon newly-applied, moist lime plaster, as distinct from painting *a secco* on dried plaster slaked down with water. In this method, the colours penetrate the plaster and the lime serves as a binder.
- Conservation** - Any action which directly or indirectly protects a work by impeding the causes of deterioration or prevents continued losses.
- Crustae** - Inlaid work on walls or floors.
- Cube** - Word used instead of *tessera*.
- Detachment** - The operation of detaching, with mechanical means, the layer of *tesserae* from its support either at the level of the *rudus* or at the level of the *nucleus*.
- Foundation** - The first, underlying, hidden levels of a mosaic, formed by the *rudus* and the *nucleus*.
- Giornato** - An area of work that can be completed in one day.
- Hypocaust** - The underground chamber or ducts of the Roman system of central heating by means of warm air flues.
- Intonaco** - The final, smooth plaster layer for fresco painting. Made from lime and sand and laid on in sections according to the amount of work the artist plans to execute each day.
- Lacunae** - Gaps in a mosaic caused by missing parts. They may comprise the loss of *tesserae* and the setting bed or, in addition to these, the loss of part of the foundation too.
- Lifting** - The operation which consists of detaching a mosaic and transporting it to a work room. This might or might not be followed by placing the mosaic on a new support.
- Mortar** - An artificial agglomerate of grains of sand held together by a binder (lime, cement, or resin) and used to hold stones or bricks together or to make a layer over some other surface.
- Nucleus** - That layer of the mosaic foundation directly below the setting bed and above the *rudus*. It consists of a fine mortar of lime, sand, crushed bricks or ceramics and stones whose maximum dimension is 2 cm. It can be applied in several coats.
- Opus sectile** - Roman mosaic made with large *tesserae* set in geometrical patterns.
- Opus signinum** - A compound of broken pieces of *terracotta* pounded together and mixed with lime. Used as a protection against humidity, its name derives from the Roman town of *Signia* (now *Segni*) in *Latium*.
- Pozzolana** - Volcanic ash used for mortar or hydraulic cement.
- Restoration** - The use of a variety of techniques to return a work of art to the closest possible semblance of its original condition.
- Rudus** - A cruder layer of the mosaic foundation, lying below the *nucleus*, and usually made up of mortar of lime, sand, crushed ceramics and stones which may be as big as 10 cm. In floor mosaics, it comes between the *nucleus* and the *statumen*; in wall mosaics, between the wall itself and the *nucleus*.
- Seam** - A cut which has been refilled with *tesserae* when the different parts of a detached mosaic have been put together again on a new support.
- Setting bath** - See *setting bed*.
- Setting bed** - Situated between the *nucleus* and the *tesserae*, this is usually invisible in the finished mosaic. Usually made of lime and marble powder, *tesserae* are set into it when it is fresh and, consequently, are held in place when it hardens.
- Sinopia** - A large drawing made on a wall in preparation for setting a mosaic or painting a mural. It serves as a guide to the artist for the general lines of the composition. It is drawn on the *arriccio*, generally in black or brown colours. Also known as a *cartoon*.
- Smalt** - Opaque coloured glass melted in a furnace and then broken up into *tesserae*.
- Statumen** - The deepest, primary layer of the foundation of a floor mosaic, lying between the soil and the *rudus*. It is formed of a bed of stone blocks which can be as large as 40 cm in diameter. In a wall mosaic, the wall takes the place of the *statumen*.
- Stone** - Another word for *tessera*.
- Strappo** - The process of lifting a mosaic by cutting the *tesserae* loose from their support. This is usually preceded by binding the surface of the mosaic to a firm, temporary support with a strong but removable adhesive.
- Support, new** - A support especially made to hold mosaics when they have been removed from their original position. It can be made of wood, of lime mortar, of cement, of reinforced concrete, of synthetic resins, etc.
- Support, old** - The *statumen* and the soil for floor mosaics. For wall mosaics, the original wall itself.
- Terrazzo** - A floor composed of chips of marble set in white or coloured cement.
- Tessella** - Another term for the much more widely used and known word "*tessera*". Both words refer to exactly the same thing. See *tessera*.
- Tessellatum** - All of the *tesserae*, placed side by side, forming the visible part of a mosaic.
- Tessera** - A piece of stone, of ceramic, or of glass, usually composed of four parallel sides, used in making mosaics. The size can range from a few millimetres to 3 to 4 cm.
- Tratteggio** - A series of parallel lines, in drawings or paintings, used to indicate general forms. Also called *hatching*.
- Treatment** - Action taken to preserve something or to restore it.
- Verde antico** - Green porphyry.

OFFICIAL PAPERS

THE CONSERVATION OF PAVEMENT MOSAICS BEFORE MODERN TIMES: A SELECTION FROM THE MOSAICS OF GAUL

by Henri Lavagne

Translated from the French
by Patricia Bonicatti

At the opening of this symposium, organized to examine present-day problems concerning the conservation of mosaics in the broadest sense of the word, it seems appropriate to present a balance sheet of our predecessors' methods. The purpose of this evaluation is neither to deplore their errors nor to pay homage to their expertise but to better understand the ways in which they approached the same difficulties which we encounter today, hoping to learn from their experience. On the technical level, a series of empirical procedures has been in use since the end of the 18th century. They were perfected in several stages during the course of the 19th century. On the administrative level, various formulae have been tried, such as state schools, private enterprise associated with museums, which have allowed the use, with varying success, of technical discoveries. We are concerned with this evolution primarily in France because it is the area most familiar to me, and also because it was there that Italian artists emigrated and found a particularly fertile field for their discoveries.

Schematically, we can distinguish four periods in the history of mosaic conservation.

The first period, which lasts from the Renaissance to the end of the 18th century, is the least well known (1). Detachment and restoration of mosaics must have been rarely practised and examples from the period are few. Infatuated with antiquity, Renaissance man encountered for the first time the problem of removing pavements. The earliest known example in France apparently is the detachment of a mosaic from Saint-Gilles (Gard), executed in 1544 at the request of Francis I in order to decorate his palace at Fontainebleau (2). We know of other examples during the course of the 17th and 18th centuries, but always dealing with small fragments, generally figurative medallions which were taken out of a geometric background and placed in frames as pictures. The point of view

which inspired these "samplings" is not very different from that which produced the *emblemata* used in antiquity.

No technical procedure from this first period of the history of mosaic conservation is known to us.

The second period (1800-1830), might be called the "Belloni-Artaud Period" after the two great pioneers and dominant figures in the field at that time. During these thirty years, the need to preserve pavements in their entirety, whether figurative or geometric, became obvious and two methods of detachment were developed concurrently. The first was that of P. Schneider, a professor of drawing from Vienne, (Isère), who, impressed by the abundance of mosaics in the region, founded a museum for mosaics (3). His procedure was simple and very hazardous: it consisted of excavating beneath the setting bed and replacing the earth with wooden props. When the mosaic was entirely detached, he surrounded it with a frame tied to cross bracings under the pavement. Only a thin layer of plaster held the surface of the tessellatum together. It was detached from the ground in its entirety and relaid in a specially-designed excavation. It is hardly necessary to point out the difficulties of this process which, besides, permitted only the preservation of small areas of mosaics.

It was F. Belloni, an Italian, who achieved decisive progress. He went to Paris in 1800 to "naturalize mosaics" at the request of the French ambassador to Rome, and remained in France for twenty-eight years as a government employee under the Empire and later under the Restoration. It is important to know about the development of Belloni's Paris career in order to understand how he was able to accomplish his work, thanks to a school which in a sense foreshadows our restoration institutes. First, a "mosaic workshop" was created for him at the Institute for Deaf Mutes. In 1802 it became the School of Mosaics, under the auspices of the

Ministry of Fine Arts. In the character of Napoleonic government, this school was destined to rival the Imperial Manufactory of Mosaics in Florence and Rome. In 1807, his spacious workshop and his students' lodgings were moved to the old Franciscan monastery at 11 rue de l'Ecole de Médecine. With the return of the monarchy in 1815, the School of Mosaics became the Royal Mosaic Factory "under the special patronage of the King". In 1826, when Belloni had to leave his old quarters, it was due to the fact of belonging to the royal household that he merited housing in the royal marble warehouse on the Chaillot hill. These details illustrate that in a state school, heir to Napoleonic centralism, a direct reliance on royal power still prevailed. It was precisely during this period that the most rapidly-completed and the greatest number of restorations were carried out in France.

Belloni's activities were twofold: the mosaic school taught his students an artistic trade and fulfilled official orders, notably the floors for the Louvre and the Tuileries, but it also played the role of a restoration institute (4). Thanks to a research project in his workshop, he perfected a method of detachment which was then already known in Italy and which soon became the method used by all museums. The adoption of this method was aided by the support of the most celebrated specialist in ancient mosaics of the time, François Artaud, Director of the Museum of Lyon, who became its promoter. We have a description of the method in his book, *Histoire abrégée de la peinture mosaïque*: first, cleaning with a brush, then drying by passing a wire mesh covered with glowing hot coals over the surface of the tessellatum (5). Next, the mosaic is lubricated with a coating of turpentine mixed with wax. Then the piece is divided into panels, the lines for cutting placed where there are lacunae, fractures, or a neutral background. A row of tesserae around the borders of these panels is next removed with a chisel. Slabs of slate or of thin marble are cut to the size of the panels. These slabs are then glued to the surface of the tesserae with a mixture of wax, turpentine and fine sand or ochre, heated along with the slabs. After drying, the panels are sawed apart with a marble cutter and detached piece by piece, beginning at the edges of the mosaic. Once detached, the setting bed is removed with a burin in order to reach the back side of the cubes. With the same mastic as before, new slabs of marble are glued onto the reverse side of the fragments, thus forming a type of "sandwich", both sturdy and mobile. After reassembling the elements in their new location, the front slabs are detached by treating with heat, while those on the reverse form the new and permanent setting bed. The joints are filled in with tesserae which were removed at the time of cutting. The mastic remaining on the surface is removed

with a chisel. Finally, polishing with pumice restores the pavement to its original smooth and brilliant condition.

This ingenious procedure was much safer than previous ones as it maintained a greater adherence to the "texture" of the tessellatum and employed relatively homogeneous materials. In examining this method, we find a certain number of our own contemporary technical concerns. The procedure was first applied in 1819 to the large mosaic "Jeux du Cirque" in Lyon (6).

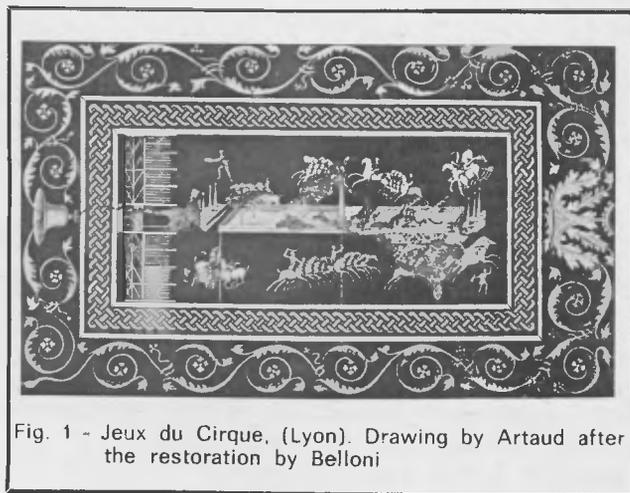


Fig. 1 - Jeux du Cirque, (Lyon). Drawing by Artaud after the restoration by Belloni

The mosaic (Fig. 1), previously considered impossible to remove because of its great size (5 m. x 3 m.), was detached and restored in Belloni's Parisian workshop in less than one year. It is also worth noting that when Belloni went to Lyon he involved the local marble workers in the project, explaining to them each phase of the various operations. This provided an important advantage for subsequent detachments: Belloni's instructions sufficed without requiring his actual presence there. So in 1820, in the case of another mosaic from Lyon, Belloni was satisfied to receive the fifty-eight segments in crates and to work on them in his studio before sending them back to Lyon, the assemblage being done by the museum itself (7). The system thus permitted a considerable saving in time and money.

For the restoration of ancient mosaics, the existence of a state factory for mosaics was a great advantage. It provided qualified craftsmen because one of Belloni's workshops was solely dedicated to the "small cube mosaics, called ancient mosaics, in the Roman style". The state factory also provided space for storing materials, Belloni having among his responsibilities the supervision of the royal storehouse of marbles used for official sculpture commissions or for inlaid mosaics, called *florentines*. Finally, the state factory provided a place for teaching and training students. There were also, however, very real dangers at a time when strict respect

for the authenticity of a work of art was not yet absolute. Moving continually from the production of modern mosaics to the restoration of ancient pavements, it was inevitable that the artist succumbed to incorrect styles or techniques. This is particularly evident in details of the mosaic "L'Amour et Pan", Lyon (Figs. 2, 3) in which Belloni's hand, excellent in technique, betrays itself by a slight stiffness which unquestionably evokes the Empire style.

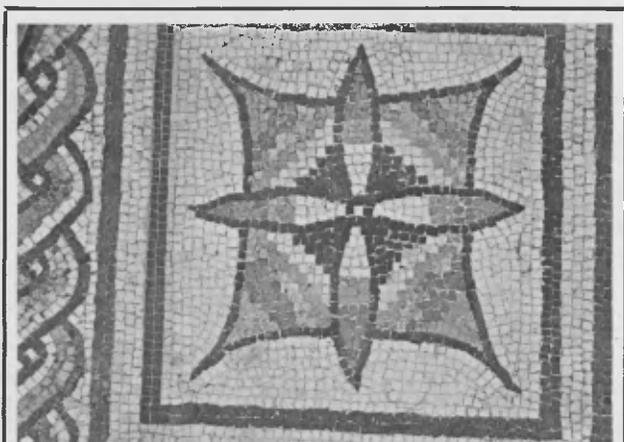


Fig. 2 - Combat de l'Amour et Pan, (Lyon) original panel

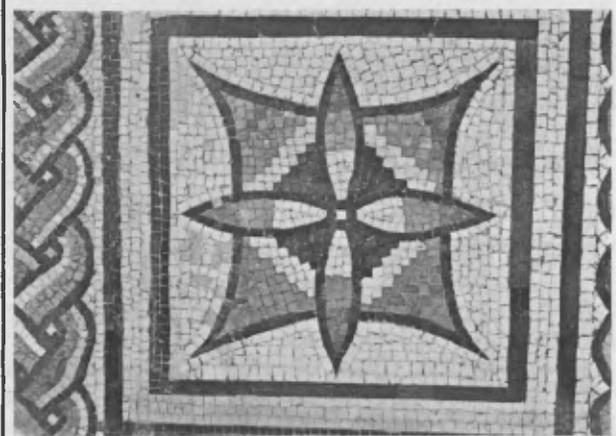


Fig. 3 - The same motif restored by Belloni

The third period (1830-1855), was a transitional phase. After the death of Belloni, followed by that of Artaud in 1838, the mosaic factory was closed and local museums reassumed the responsibility for all the work of mosaic detachment and conservation. Not having specialists at their disposal, these museums called upon the architects in charge of the conservation of classified works of art in the Department of Historic Monuments. Belloni's method was modified and made more flexible. We have an example of this in the description of the detachment of a mosaic from Vaison-la-Romaine, (Vaucluse), in 1838, executed under the direction of P. Renaux, the architect of the *département* (8). The sur-

face, 18 square metres, was divided into thirty-four panels. Sheets of cardboard were then attached with heated bitumen, leaving a seam for the saw cut between each panel. Planks of fir wood were glued to each of the panels. A marble saw was then used to cut vertically around the panels, following the seams. The task of detachment beneath the pavement came next, the earth being progressively replaced with bundles of sticks. The detachment of the tessellatum was accomplished by rupture, following the line of cleavage separating the rudus from the nucleus. Each panel was then lifted out and its backing reduced to a thickness of approximately 9 centimetres to which a coat of plaster was applied. All the panels were then placed on a bed of straw in a wooden crate. The plan was to reassemble the mosaic in the Musée Calvet in Avignon, where it was to remain, and to detach, by a heating process, the sheets of cardboard glued to it by bitumen. Unfortunately, the large size of the pavement (6 m. x 3 m.) did not allow its immediate placement. The sheets of bituminous cardboard dried out, the plaster turned to dust, and the cubes became completely detached from each other (Fig. 4). Only in the last period of this history of mosaic conservation was a new, safer method perfected by a second generation of Italians established in France.

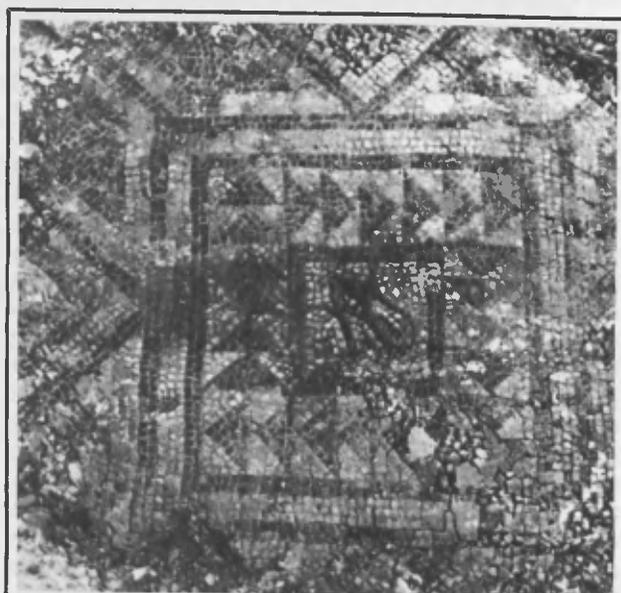


Fig. 4 - Fragment of a mosaic from Vaison-la-Romaine, detached by P. Renaux

The fourth period was that of the Moras, (1850-1913), and we owe to this family, two generations of which lived in France, the major part of the mosaic restorations in the southern part of Gaul. Originally from Udine, the Mora brothers established their residence first at

Lyon, then at Nîmes. They were, like Belloni, creators of modern mosaics but they worked still more as restorers of antique pavements. In any case, they constituted a family-run private enterprise with no ties, other than contractual, with state museums. Their methods differed from those of their predecessors in several respects: strong paper was attached to the surface of the tessellatum with a glue composed of a mixture of gum arabic and rye flour. Strips of cloth were carefully stretched across this paper and held in place with the same glue. The cutting operation was identical but the back surface of the mosaic was scraped down to the nucleus. A rather thin bed of tessellatum was thus obtained, which was held only by the shell-like layer glued to its surface. The prepared fragments were then sealed afresh in a cement which formed the final laying bed. Cloth strips allowed far more flexibility in detachment and a greater adherence to the surface, but the choice of a plane of cleavage between the tessellatum and the nucleus made the process of separation very delicate. Besides this, the very fragility of the fragments required that they remain in small sections of scarcely more than 60 square centimetres. This meant that there were numerous joints to cover at the time of reassembly. Due to the virtuosity of the Moras, however, these joints were perfectly hidden.

The two generations of these artists worked very differently from each other. The first didn't hesitate to entirely replace missing fragments, and the result is often baffling, due to the finesse of the execution and the boldness of the invention. We have a good example in a pavement from Vaison-la-Romaine, (Vaucluse), detached by E. Mora in 1861 (9). As the museum of Avignon was unable to acquire the segment of the original mosaic, the artist entirely reconstructed the missing fragment. Comparing it with the authentic piece, we are surprised to see that all the motifs which were missing have been entirely invented (Figs. 5, 6). However, we can better understand the liberty taken by the artist in regard to the original work of art if we recall that this period greatly favoured creative work in mosaics. In fact, under Napoleon III, mosaics came back into style with the help of Garnier, the architect of the Paris opera house, who entrusted a part of the great hall to the Venetian mosaic masters Salviati and Facchina. Facchina himself was in charge of restoring the mosaic from Lillebonne, (Seine-Maritime), in 1871 (10). It is not surprising, therefore, to find in the work of the restorers of this period an echo of the rich creativity they were expressing in their own works at the same time.

The work of the second generation of the Mora family was less marked by the artistic trends of the time. If we consider the mosaic from Luc-en-Diois, (Drôme), (Fig. 7), restored by C. Mora in 1891, we notice that a certain "objec-

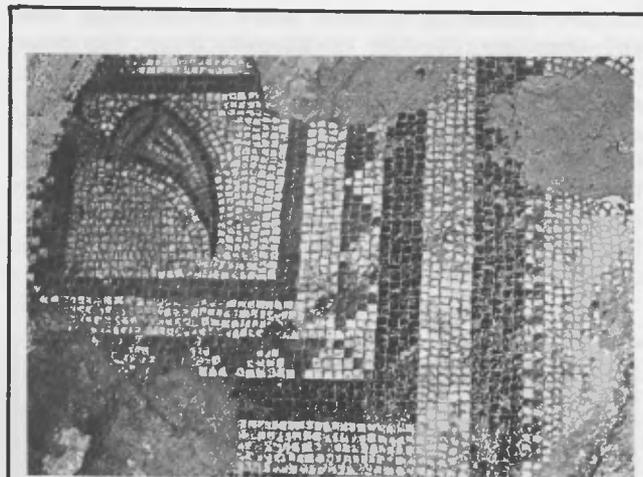


Fig. 5 - Fragment of a mosaic from Vaison-la-Romaine, original part



Fig. 6 - The same motif restored by E. Mora in 1861

tivity" is beginning to mark the restorer's approach (11). After the death of Claudius Mora, just before the First World War, restorations were increasingly left to the initiative of the provincial museum. They became rare again, because of the lack of real specialists, and they were characterized by the regular use of cement and animal glue.

The sole purpose of this report has been to give a brief summary of the evolution of techniques in the restoration of pavement mosaics, and to place them in their historic context. It is evident that the most favourable periods have been those which combined a taste for archaeology and a desire to save an artistic heritage (as under the First Empire) with, on the other hand, an artistic movement which led to the creation of modern works. Whether within the governmental framework of Belloni's factory or that of private enterprise under the Moras, creation and restoration were never separated. This "coexistence" in the same workshop of a technique dedicated to two totally different aims caused inevitable errors. A second point to re-

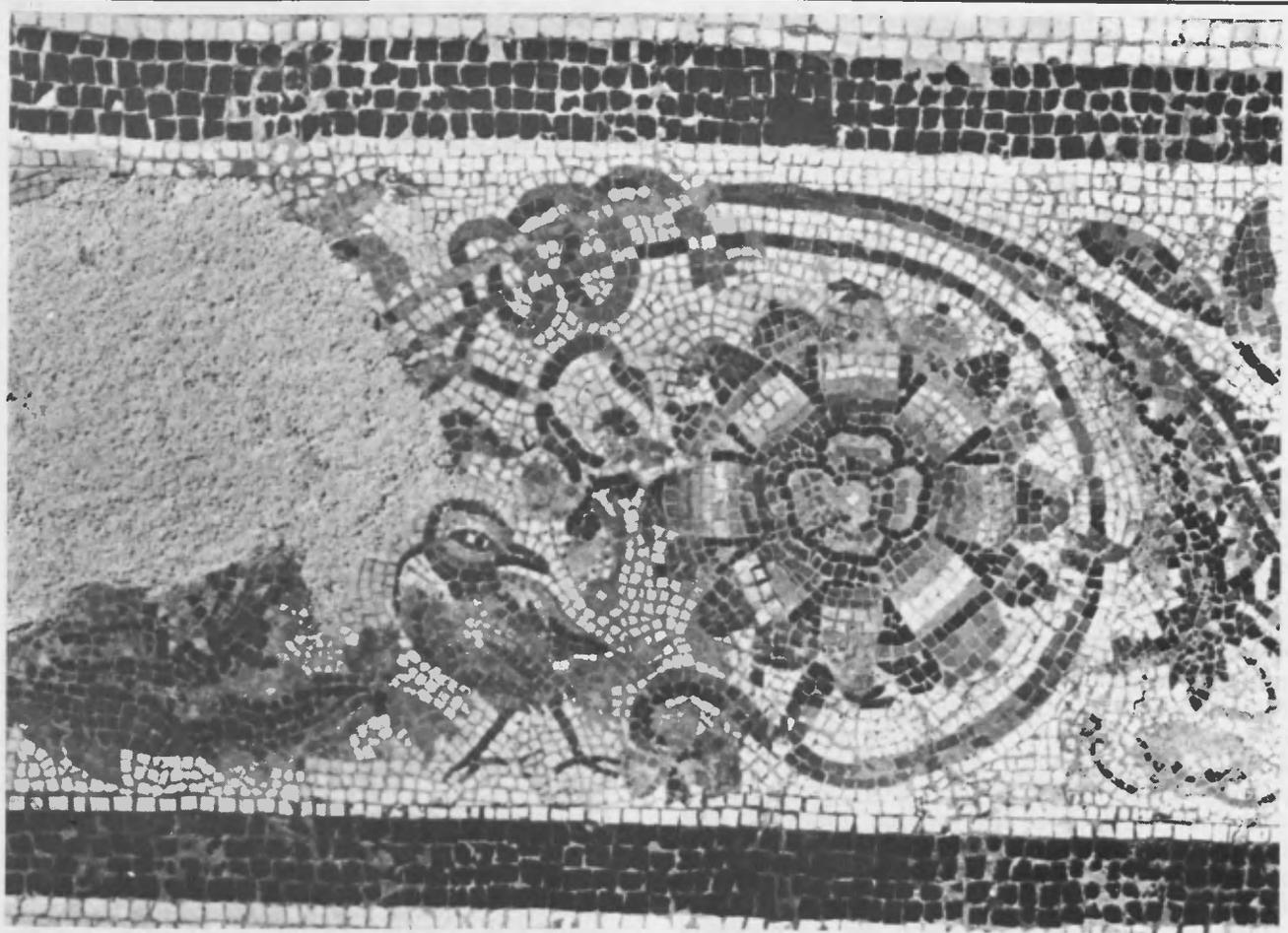


Fig. 7 - Fragment of a mosaic from Luc-en-Diois, restored by Cl. Mora in 1891 and by Cl. Bassier in 1972

member is the necessity of transmitting knowledge. When the masters of a school disappeared without having trained disciples, a phase of stagnation ensued. It is clear that the most fruitful period was that of strict collaboration

between the technician, Belloni, and the scholar, Artaud. It is to them that we owe the birth of our science.

The discussion which followed this lecture will be found on page 37.

Notes

1. Of the period before the Renaissance we know very little. Only a few details have come down to us of the methods used in the 8th century when the Pope authorized Charlemagne to detach pavements and wall mosaics in Rome and Ravenna. See P. Verzone, "La demolizione dei palazzi imperiali di Roma e di Ravenna nel quadro delle nuove forze politiche del sec. VIII" in *Festschrift Fr. Gerke*, Baden-Baden, 1962, pp. 77-80.
2. J. Poldo d'Albenas, *Discours historial de l'antique et illustre cité de Nîmes*, Lyon, 1560, p. 59.
3. J. Delorme, P. Schneider, Vienne, 1847. P. Schneider, *Histoire des antiquités de la ville de Vienne*, Vienne, 1880. Schneider was active at Vienne from 1756 to 1816. His book was published after his death.
4. For more details, see the unpublished archives in the Archives Nationales, Paris, series 02, 03.
5. F. Artaud, *Histoire abrégée de la peinture en mosaïque, suivie de la description des mosaïques de Lyon... ainsi que d'un aperçu relatif au déplacement de ces pavés*, Lyon, 1835.
6. For more on this pavement, see H. Stern, *recueil général des mosaïques de la Gaule Lyonnaise*, II, 1, no. 73.
7. *Ibid.* II, 1, no. 1.
8. On this mosaic, see H. Lavagne, "Trois mosaïques inédites de Vaison-la-Romaine", in *Revue archéologique de la Narbonnaise*, X, 1977, pp. 183-188.
9. G. Lafaye, *Inventaires des mosaïques de la Gaule*, Paris, 1909, I, nos. 121 and 123.
10. A. Blanchet, *ibid.*, II, no. 1051. J. P. Darmon, *La mosaïque de Lillebonne*, 1976, and "La mosaïque de Lillebonne aujourd'hui", in *Actes du colloque Cochet*, Rouen, 1975.
11. G. Lafaye, *Inventaire*, no. 137.

THE WALL MOSAIC: HISTORY OF RESTORATION, EVOLUTION OF TECHNIQUES

by Irina Andreescu

Translated from the French
by Elisabeth Schwartzbaum

The history of the restoration of wall mosaics, of its methods and processes, is in many cases identical with the history of the monuments which the mosaics were intended to decorate. The art of mosaics, costly as a result of the materials used and the highly skilled workmanship required, is an art of tradition and patronage. It cannot be improvised, either in its techniques or in its artistic quality. The latter is largely conditioned by the virtuosity of the artisans charged with rendering images, theoretically made to last, by means of coloured glass and finely cut stone. The famous definition that Ghirlandaio gave to mosaics, "the true picture for eternity", was often cited later for its inexactitude.

Because the art with which we are concerned presupposes substantial means, it was consequently in all periods considered an ideal expression either of power or of high spirituality, depending on the case, or even of both at once.

In the Mediterranean basin during the Roman period rich private individuals used mosaics to decorate certain parts of their houses. Later, the Byzantine state utilized mosaics profusely to illustrate, in a durable fashion, Christian dogma in the decoration of the churches, and the splendour of the Emperor, Christ's representative on earth, in his dwellings. Mosaics served the Popes for comparable purposes. Lastly, the powers fighting for political supremacy, and desirous of comparing themselves with, imitating, or supplanting Byzantium, did their utmost to promote lavish decorations. These, charged with political and religious significance, were created *ad hoc* in mosaics, most often by Byzantine artists. It was thus that the Arab caliphs, Charlemagne, the Orthodox princes of Kievian Russia, the patrons of Mount Athos, those of Monte Cassino, the doges of Venice and the Norman kings of Sicily, to mention only the most famous, contributed to the diffusion of this art, which had become a true status symbol of the Middle Ages.

Of those monuments that have been preserved to our day (a small part of the whole), many,

almost all of them churches, have kept their function and therefore the need for their decoration. However, the churches already covered with mosaics in the Middle Ages were kept in a good state of repair during the course of the centuries by artisans whose artistic conception was greatly different from, if not opposed to, that of the first mosaicists; this is the case of the monuments in Italy, from the Renaissance on. Churches in the Byzantine Empire were transformed during the course of their history into mosques, and the mosaics representing Christian images were destroyed or hidden from view.

Having ceased to live actively within its traditional formulae, the art of mosaics soon became a rare craft and only survived to our day through restoration workshops, while it suffered various fates. On the technical plane, there are two periods in the history of restoration: the first comprises modifications or repairs made on mosaics in the era when mosaic work was still an art and an active craft. The second, which begins during the Renaissance and continues to the present, comprises restoration by the "followers"; from a certain time onward, they attended to the conservation of mosaics, which had, with time, become an artistic and cultural heritage. It should be mentioned here that modern decorative mosaic work is carried out with techniques and for purpose fairly different from those which, established in antiquity, flourished during the whole course of the Middle Ages.

Among the various books on mosaic making, on its existence through history and the history of methods of restoration, a few date from the end of the last century, that is, from the time of the first modern controversies in this field. The interest, mostly documentary, of these books lies principally in the quality of the authors; one was Edouard Gerspach, himself a restorer of mosaics (1), the other, Piero Saccardo, proto of St. Mark's in Venice, and in that capacity director of restoration work and of the mosaic workshop of the basilica (2). Not only did they take an interest in the history and vicissitudes

of mosaics through the centuries, but their engagement in the promotion of the least destructive means of conserving these mosaics was active and competent. Other works dedicated to mosaics have since appeared, which treat the history of their restoration in different ways, but it is the debates of the second half of the 19th century which will open the way for a new concept of restoration (3).

I do not propose to summarize here in detail facts well documented in this literature. It is on other examples that I would like to dwell - especially on (a) certain restorations which took place in the Middle Byzantine period, and which I have on occasion had the privilege to examine closely, as well as on (b) certain more recent restorations of the end of the 19th and the beginning of the 20th centuries, which are perhaps more interesting to us because they are historically closer and thus more instructive as regards their philosophy and their weak points. I will try to present above all examples known to me first-hand and to support them with the evidence provided by illustrations, without the intention of touching on all the chapters, much less attempting to exhaustively cover the subject of mosaics. Please forgive my rapid treatment of the vast Roman chapter, which has been traditionally and still is today the subject of numerous studies (4), as well as the mosaics of the Norman kings of Sicily (4a).

Our documentation comes mostly from field research carried out on a certain number of Middle Byzantine monuments among the most important preserved and which date from the 11th and the 12th centuries (5). This research has allowed the study of the technical aspect of all these monuments, getting to know their characteristics, and their extraordinary unity in spite of their geographical distance from each other. I refer to the technical unity common to mosaics throughout the 11th century and through the beginning of the following century, starting from St. Sophia of Istanbul (6), passing through Hosios Loukas in Phocis (7), St. Sophia of Kiev (8), Nea Moni of Chios (9), the older parts of St. Mark's of Venice (10), Torcello (11), the Basilica Ursiana of Ravenna (12), the mosaics of St. Michael of Kiev (13), those of San Giusto of Trieste (14), finally, those which represent the archaic trend in the church of Daphni (15), in the first half of the 12th century. If the style of the compositions records variations and evolutions which help us to compensate somewhat, by use of typology, for the lack of any precise dates for these monuments, the homogeneity of the technical methods - from the setting of the mosaics in their mortar bed to the range of colours represented in the glass pastes or in the natural stones - as well as the use for certain figures of the same, well - fixed recipes, this homogeneity then, more or less generally ascertained - both in technique and typology - allows

us to define the most important characteristics of this craft for a given period.

Judged by the same criteria, another series of Byzantine mosaics, slightly later, shows technical traits somewhat different from those which we have grouped above. These mosaics are preserved in St. Sophia of Istanbul (16), at Daphni (17) (in the most advanced tendencies of the workshop active there), but above all at Saint Mark's of Venice (18), elsewhere in the lagoon (19), and in Norman Sicily (20). If it is possible to distinguish fairly clearly on the technical plane between two groups of mosaics, near to each other in both time and space, it is all the more so when we are confronted with later interventions separated from the earlier by generations and by centuries. In other words, repairs and restorations nearly always betray themselves to the experienced eye, whether it is a matter of Byzantine or of Western mosaics, dating from the early Middle Ages or from the 14th century. Armed with this instrument, the experienced eye, we are going to identify these changes and their methods of work

Always, but especially during the period of the iconoclast struggles and after the restoration of images, several mosaics changed part of their decoration for ideological reasons. Since it was so costly to redo a large surface in mosaics, it was considered sufficient, in certain cases, to destroy or redo, accordingly, only the images, while preserving the gold ground or the geometrical decorations which were ideologically benign. Of the few examples which have come down to us, the most spectacular - or nearly - concerns the mosaics (destroyed in 1922) of the church of the Dormition in Nicea. Indeed, the most recent decoration, which represented in the conch the standing Virgin with the Child, visibly replaced the image of a cross (which had been covered by gold cubes, once the cult of images had been re-established, the cross itself replacing in turn an older image of the Virgin destroyed by the iconoclasts) (21).

A similar case is suspected (for the moment without clear archaeological evidence) for the representation of the Virgin in the conch of St. Sophia of Salonica (22) and also for the decoration of the apsidal conch of St. Sophia of Istanbul (23).

Apart from ideological struggles, other events required the partial replacement of certain decorations: such is the case of the imperial portrait of Zoë and of two of her husbands, who succeeded each other by her side as donors at the church of St. Sophia of Istanbul (24). The mosaic panel situated in the south gallery of the church shows clearly a modification effecting the identity of the husband of the empress. The inscription next to the figure of the emperor concerns Constantine Monomachus; but this inscription was inserted later, in place of an earlier inscription, and the substitution is visible

because of certain letters which are more close-set than the others, in a space calculated for another name. The head of the emperor was apparently redone completely in order to represent Monomachus, while keeping the body of the preceding emperor. There is in the panel a mystery yet unexplained concerning the sutures around the other two heads of the panel, Christ and Zoë. The traces seem also to indicate a restoration of these heads, although the reason for this operation is not at present clear. Another example of decorations whose programme was modified as a result of political changes is found at Ravenna, in the mosaics of St. Apollinare Nuovo, where scenes ordered by Theodoric, king of the Goths, were erased by his successor in the decorating of the church, the Bishop Agnello (25).

Finally, in the course of campaigns organized in the Veneto, scaffolding constructed at St. Mark's has permitted us to study closely and to demarcate in the eastern cupola two phases in the decoration of the mosaics representing the Prophets and the Virgin around Christ Emmanuel. The second phase seems to be the consequence of the destruction by an earthquake of the original mosaics. The suture dividing the Prophets in two groups passes through the field of gold which extends between two figures, in the middle of an inscription which continues, unchanged, except for the colour of the cubes: black on one side, dark blue on the other. Were it not for the change in style (a clear indication of the time lapse between the two phases), and also for the introduction in Phase II of a supplementary figure, which reduces the free space between the figures of this phase (26), the overall programme and the composition of the decoration as we see them, (it all dates from about the middle of the 12th century), follow and "restore" the original decoration, older by half a century.

*A greater surprise awaited us when we examined the mosaics of Torcello. Although a chronological difference had already been noted within the mosaics decorating the main apse (on the one hand the Apostles of the hemicycle, products of an earlier period, on the other hand the Virgin in the apse and the Annunciation, results of a later restoration more than a century distant from the Apostles), the examination of the western wall (decorated, it seemed, in one breath, with mosaics that were known to have been restored in the 19th century, and which represent the Crucifixion, the Anastasis and the Last Judgement) (27) allowed the discovery of a very fine restoration of the original composition. The workshop active in the restoration can be dated by its style to the end of the 12th century. Called upon to repair considerable damage suffered by the mosaics, this workshop remade to a great extent the earlier decorations, while respecting the former model even in its details, especially where the damage cut through the

middle of a scene. When it was necessary to redo an entire group of people - the Apostles, Judges on our right - certain differences in style became more visible at Torcello as they did in the eastern cupola at St. Mark's.

These last examples, lacking any ideological or political meaning, prove clearly the "archaeological" attitude of the team entrusted with the remaking of the destroyed mosaics, without taking into account the fact that to complete the missing parts our mosaicists were faced on the technical level with a routine piece of work which they accomplished with no difficulty. This is because in the Middle Byzantine period the "new" mosaicists, the restorers, still understood their elders (of whom they were the successors) down to the last nuance. They knew equally well the iconographic themes they had to complete and strove to keep a certain stylistic discretion, rendered fairly easy by their essentially similar technique. At their best, these parts added later cannot be identified except with the aid of research carried out on the mortar bed in which the tesserae are implanted. The more recent mortar appears clearly demarcated in relation to the earlier bed, and the different compositions of these mortars is evidence of the length of time between the two phases. Little by little, however, the range of materials used (glass and stones) slowly changed, and at the end of the Middle Ages this change, which was becoming more and more evident, went hand in hand with increasing modifications of the style.

The conquest of the Byzantine Empire by the Turks put an end to an art which had largely served to decorate monuments of the Christian cult. The absence of important patrons prevented its continuation in other parts of Eastern Europe. In Italy, in Rome and Florence, after the great development of the 13th and 14th centuries when old mosaics were redone and other mosaics flourished in a last burst of this traditional art, painting took over for good. The Renaissance was to relegate mosaics to an auxiliary rank in the service of a different plastic conception. The last great mosaicists were also the first painters of the Renaissance. When a Giotto or a Pietro Cavallini used mosaics as a means of expression, one can understand why never again could traditional mosaics, in the "Greek" manner, regain their importance. Of Cavallini, Vasari said, à propos the former façade of St. Paul's outside-the-walls, that "he had a liking for the old Greek manner, which he mixed with the style of Giotto".

Although one chapter in the history of mosaics had just ended, this art nevertheless did not disappear. Its development continued in parallel directions in Rome and in Venice. In the latter city, once the "Byzantine school" was extinguished, mosaic work began again in the 15th century with the decoration of the chapel of the Madonna dei Mascoli. When we look at these

mosaics for which Florentine artists had been summoned, we are struck by the distance separating them from the first decorations of the main portal of St. Mark's. With the passage of time, earthquakes, fires and other calamities, parts of the old mosaics were destroyed and had to be restored: for example, the Christ Enthroned of the main apse, mentioned in chronicles as having suffered damage as a result of two major fires which had ravaged the Basilica in 1419 and in 1489. The mosaic was redone, completed in 1506, as is attested by the signature of the mosaicist Petrus (28). It is interesting to note that the Christ of Petrus copies in all details of style a prototype that one can clearly perceive and which can be dated to the 12th century. Other mosaics of St. Mark's redone in the 15th century also bear witness to a desire to preserve the earlier composition as faithfully as possible.

In the 16th century, this respect for the original work was completely submerged by the impetus of great Venetian painting. Mosaics became an instrument in the service of painting, which was inevitable when at St. Mark's the cartoons were the work of Titian, Veronese, Tintoretto, or else, at Rome, of Raphael. As a result of the debates between two rival factions who worked in the Basilica during the 16th century, we know some of the methods by which the mosaicists of St. Mark's executed mosaics following cartoons. The mosaicists Bartolomeo Bozza and the Bianchini brothers denounced the Zuccato family, their competitors at St. Mark's, to the Procurator in charge of Finance, accusing

them of having rendered certain objects in painting and not in mosaics. The tribunal, formed by Titian, Paolo Veronese, Tintoretto, Jacopo Pistoia and Andrea Schiavona, favoured the side of the accused, of whom Titian was a long-standing friend and ally. He himself bore witness as having furnished drawings to Zuccati and finally the Bianchinis heard themselves accused by Tintoretto of faults (of form and proportion) in certain drawings and by Titian of a "dishonourable border". This happened in 1563 (29).

The Zuccatis well known at the time, celebrated by Vasari, have left us enormous surfaces decorated by them in St. Mark's, the fruit of a collective work of several decades. Their mosaics often took the place of the old mosaics, no longer to the taste of the painters of the Renaissance. It is said that it was Titian who proposed having the old mosaics replaced by new ones in the current taste, which was done, beginning with the atrium in 1530, at the level of the clerestory (30).

It was only in 1610 that the Venetian government began to worry about the *conservation* of the existing mosaics and, by a decree, to "severely condemn the deplorable abuse of disassembling the old mosaics in order to make new ones". And in the case where replacement would be inevitable because of the poor state of the mosaic, a very exact drawing was to be made so as to redo the works in the same manner (31). We know one of these drawings made between 1611 and 1617, when the old Communion of the Apostles on the east wall of the north transept was replaced by the same composition following a cartoon of Aliense. This drawing (Fig. 1), to-



Fig. 1 - Venice, Archivio di Stato, drawing of the original composition on the east wall of the north transept of St. Mark's before it was replaced by the present work

gether with the results of the substitution still visible today, and with all the other mosaics replaced in the 17th century, bears witness to the enormous difference separating this mosaic-painting from what we understand today as a restoration. However, the knowledge of this difference was to take hold in the minds of a few enlightened persons, worried to see the disappearance of vestiges of former times. Little by little, the concept of restoration itself was to be modified by this, and in two directions. First, by the removal of endangered mosaics to other architectural supports. Next by the completion and the repair of the ruined parts of mosaics, "faithfully" imitating the style and the technique of these works.

The physical transfer of old mosaics also has its history, which begins with the most simplistic manifestations, i.e. the destruction of mosaics in order to recuperate the materials. Written sources attest to the transportation of mosaics from Ravenna to Aachen by Charlemagne, who wanted to decorate his church with them (32); the reusing of all kinds of materials - including mosaics - by Basil I in the decoration of his Nea Ekklesia (33); of the destructions of which the Patriarch Michael Cerularius was accused, who, it is said, driven by his avarice, stripped churches of their mosaics and used them for his works (33a); lastly, to the transport by the Venetians, in their share of the booty after the Fourth Crusade, of mosaics and other decorative materials from Constantinople to Venice (34). In all these examples we are dealing with the transport of mosaic tesserae, raw materials in glass paste and perhaps in fine marble.

An example of a more complex transplantation of an old mosaic into a renewed context could have been the head of Christ (dating from the 4th or the 5th century) in the apse of St. John Lateran during the restoration undertaken there by Torriti at the end of the 13th century. However, the destruction of the old mosaic in 1884 and its replacement with a copy does not, unfortunately, allow us ever to resolve the modern controversy on the nature of the operation: was the head of Christ really saved by Torriti and incorporated in the renewed apse, or was it only a copy, separately worked in the manner of an *emblema*, thus explaining the autonomous mortar bed on which it was found at the end of the last century (35)? It seems also that repairs on the mosaics of St. Peter's undertaken by Innocent III at the end of the 12th century, represent a restoration in the sense that the old parts were preserved in place, instead of being completely remade. We can no longer judge in what measure the mosaics of St. Paul's outside-the-walls, restored after 1218 under the auspices of the same pope, were inspired by, copied, or incorporated the mosaics of the 5th century because the present decoration dates from around 1823. Among the oldest restorations still visible

today are those in some panels in the nave of Santa Maria Maggiore (36).

Later, also in Rome, several mosaic fragments were removed from their architectural framework more or less successfully. The only fragments preserved from the old church of St. Peter's date from the restoration of Innocent III, cited above, and were detached in 1582 on the occasion of the destruction of the old basilica. In the same period, between 1609 and 1631, the mosaic fragments of the oratory of John VII were also removed. The textures were damaged in all these cases, to different degrees, and although the iconographic interest of these fragments is incalculable, their style has lost many of its distinctive qualities. The "Navicella" of Giotto, as we see it today, dates from the 17th century. To replace the original, destroyed mosaic, it was redone from a life-size cartoon executed in 1628. The analysis of this mosaic, with its successive layers of modification, has caused much ink to flow.

A more successful example of the removal of mosaic fragments from their original frame is provided by the heads of saints and the figure of a standing orant Virgin, in the museum of the archbishopric of Ravenna. These fragments come from the former church of the Bishop Ursus, redecorated with mosaics in 1112 and destroyed between 1734-1745 to make way for a new construction (37). In addition to a drawing of the entire composition, the mosaics (detached from the wall, preserved in wooden crates, the only evidence of this decoration and the only example in the northern Adriatic area dated by an inscription), have come down to us in an excellent, almost impeccable state.

Attempts at transporting a mosaic composition in its entirety from one place to another are known only from the 18th century on. The mosaic of the triclinium of the Lateran Palace, detached from its apse under Clement XII (1730-1740), fell into fragments impossible to put together again. It was completely remade under Pope Benedict XIV in 1743 in the palace square where it is visible today. This work, carried out under the direction of Cristofari, head of the pontifical mosaic workshop, is extremely mediocre and preserves only the iconography of the original.

In the 19th century, the operation was attempted on a larger scale, in order to move the apsidal mosaic, bought at auction by the crown prince of Prussia in 1837, from the church of St. Cyprian in Murano (Figs. 2, 11) to the Friedenskirche in Potsdam (38). The mosaic was cut into squares and work on it continued for two years. The results of this first successful *strappo* are still, however, a long way from today's requirements and the intervention of modern mosaicists is too visible. Another apsidal mosaic, belonging to the church of San Michele in Africisco, Ravenna, was moved at the same



Fig. 2 - Potsdam, Friedenskirche, general view of the mosaic from the ancient church of St. Cyprian in Murano

Figs. 3-8 - Series showing the different phases of the *strappo* method (here practised on the mosaics in the north apse hemicycle of San Giusto, Trieste in 1947)



Fig. 3 - Removal of the mosaic and of the first layer of the support, revealing the second layer with its indentations for holding the mortar more securely



Fig. 5 - The new mortar bed is ready to receive the mosaic



Fig. 4 - The stones of the wall itself are revealed when all the mortar has been removed

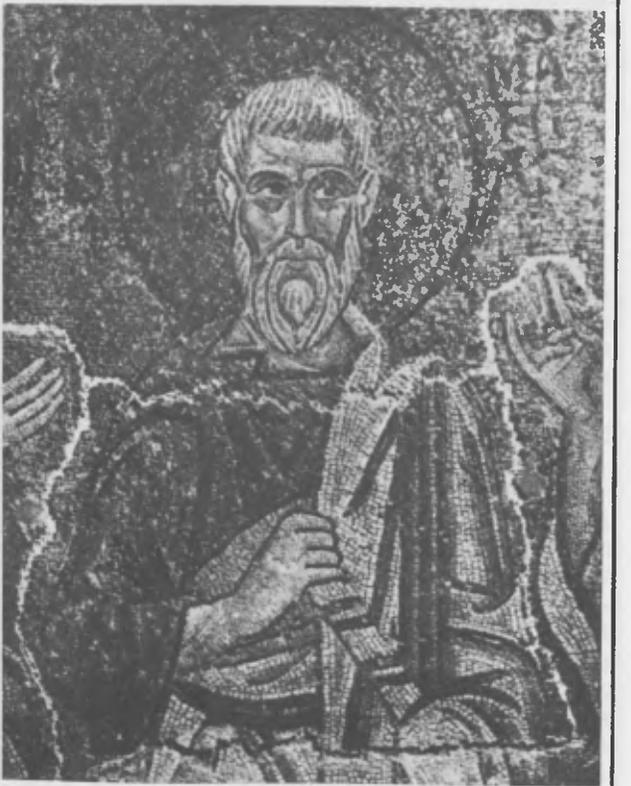


Fig. 6 - The mosaic after being put back in place

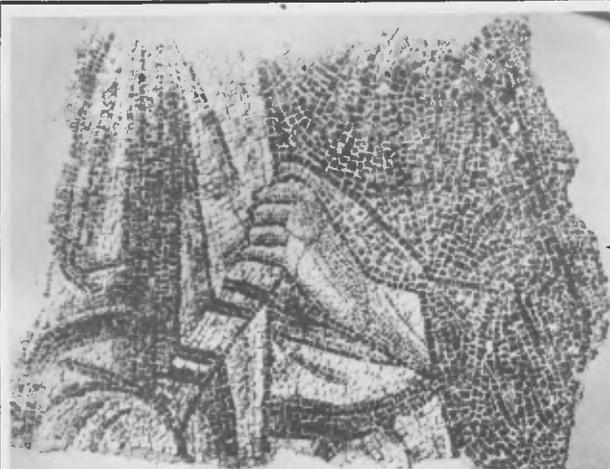


Fig. 7 - Back view of the detached mosaic with the mortar removed



Fig. 8 - The removal of the mosaics, successive layers of mortar, and the cleaning of the underlying masonry, brought to light a series of windows which existed before the present mosaic decoration of the apse

time, and approximately in the same manner, to the Berlin museum. After a long wait and many mishaps, it was reconstructed only at the beginning of this century, with similar results (39). For the most part, it is a modern reconstruction.

The technique of mosaic removal, in its early stages in the examples given above, consists in detaching the mosaic from its support in order to clean and consolidate the wall and/or the layers of mortar which hold it to the wall, and the reapplication of the mosaic on a new, sound bed (Figs. 3-8). Used on large surfaces during the greater part of the 19th century, and still in the 20th, recognizable by its grid of "seams", this technique has improved greatly since its beginnings, to the point where today it no longer leaves the mark of the squares when put back into place. The *strappo* technique nevertheless has other disadvantages, mainly the general appearance of the surface after it has been removed from its support and put back in place. The texture suffers a lack of cohesion.

Besides moving mosaics, it was often necessary to redo or restore partly damaged mosaics without removing them. The "archaeological" solicitude of the mosaicist as restorer appears fairly early in certain cases, such as at Torcello, for which a document dated 1757 allows the placing of a name on the repairs - clearly "settecenteschi" - still visible in the Chapel of the Holy Sacrament. Pietro Monaco is documented as having remade twenty-five square Venetian feet of mosaics at Torcello and as having consolidated and washed one hundred and fifty others (40). In 1751 he signed his name under the mosaic of Daniel, in the scene of Susanna and the Elders, on the west wall of the north transept of St. Mark's. It is interesting to note the double standard used by Monaco: Daniel, newly executed, is a post-Renaissance painting rendered in mosaics, while the fragments added at Torcello to complete mosaics of the Byzantine period, followed their schemas and rules. However, besides Monaco's inability to restore the texture of the surface covering it with compact small tesserae in the manner of the old masters, he also used the same material in Torcello that he used for his Daniel in St. Mark's. The white, cyclamen, rose and green glass paste, foreign to the original palette of the Torcello mosaic, and less carefully cut, also betrays the period of the restoration.

We know that a certain Leopoldo dal Pozzo, a Roman mosaicist working in St. Mark's between 1715 and 1745, executed the St. Jerome on the north-west pendentive of the northern cupola. He worked from a cartoon by Piazzetta and in the style of the period. To the same dal Pozzo, said to be a restorer (41), we could perhaps ascribe the symbols of the four Evangelists in the same cupola, "in the 12th century style", which do not seem to have existed originally, and the restoration of parts of the original mosaics of the 12th century. The restored sections (in the scene of the destruction of the temple of Diana, in the figure of St. John as an orant, etc.) generally follow the medieval technical formulae. Only upon close analysis can we

identify errors of interpretation in the reconstruction of the movements of the figures, or marked differences between the colours of cer-

tain materials used by the two workshops. Although less evident than in the restorations of Pietro Monaco, these differences provide a fairly



Fig. 9 - Serrès, Métropole, apse mosaic now totally destroyed. Communion of the Apostles, Detail: note that the missing parts of the mosaic have been replaced by paint



Fig. 10 - Torcello, Santa Maria Assunta. Anastasis, detail: Archangel Gabriel



Fig. 11 - Potsdam, Friedenskirche. Mosaic from the church of St. Cyprian in Murano, detail: Archangel Michael

certain guide to recognizing dal Pozzo's work. So does the use of a "stucco" setting bed which dal Pozzo brought from Rome and which goes back as far as the end of the cinquecento. Consisting of the use of an oil mastic in place of lime cement for the mortar bed of the mosaics, this process had the advantage of slow drying but also the disadvantage that the oil stained the stones. It was theoretically abandoned at St. Mark's shortly after the disappearance of dal Pozzo (42).

Toward the beginning of the 19th century, an interest in the old, original mosaics developed. The crown prince of Prussia set a good example, as we have seen above. In Russia in 1843, while Solnzeff, of the Academy of Fine Arts of St. Petersburg, was restoring the frescoes of St. Sophia in Kiev, 11th century mosaics were discovered under a layer of plaster and oil overpainting (43).

The discovery of the mosaics of St. Sophia in Constantinople followed closely when the Fossati brothers were called by the sultan to strengthen the monument. They were astonished at the state of conservation of these mosaics and moved by their beauty. On the orders of the sultan, for religious reasons, they were forced, however, to cover them with plaster

but not without first having taken abundant notes, in the form of drawings (44). The Byzantine mosaics in Greece and Turkey had survived more or less intact under their layer of plaster, suffering only the injuries of time (Fig. 9). It was not until the end of the 19th century that they were to become a training ground for restorers.

Italy, on the other hand, remained the only country where the mosaics in functioning churches were constantly maintained. As early as 1727, in the time of Benedict XIII, a workshop existed in the Vatican, La Reverenda Fabbrica di San Pietro. When it started, it was meant to reproduce famous paintings in a more lasting material. Napoleon, at the beginning of the 19th century, encouraged the art for the decoration of public buildings, as did the czar of Russia. In 1803, Napoleon organized a school for mosaicists in Milan in which Vincenzo Raffaelli was among the teachers. One of his pupils, Giovanni Moro, was to leave his mark on all mosaic restorations in St. Mark's through 1858. Although the few firms patronized by the state were mainly occupied with the production of modern mosaics, there were other private workshops of varying sizes flourishing almost everywhere in Italy.

In a way, these workshops, among which we

must also count the Vatican's, by their method of working brought about the ruin of the very mosaics they were supposed to restore. Rare are the Italian monuments that escaped this fate. For Rome and its surroundings, the archives provide numerous data which can be corroborated by a close examination of these mosaics *in situ* or by photographs taken after the work was done. The same situation applies to Ravenna. There, missing parts in a mosaic had been filled in by painting (Fig. 9) but now mosaics were being used (45). Venice also suffered the same fate. Most of these restorations had no basis in iconographic research and the results show it. According to a system of payment calculated by the surface area, hundreds of square metres were completely redone, thereby destroying the old mosaics. The slow and meticulous work of incorporating the old parts that had survived into the new work was not paid for at all (46).

In Italy we find the same mosaicists working in many different places. These 19th century restorers were Liborio Salandri, working in Rome, at St. Mark's in Venice, and at St. Apollinare Nuovo in Ravenna; Felice Kibel, who worked at St. Costanza in Rome and at St. Apollinare Nuovo, after Salandri; and Giovanni Moro, who worked at St. Mark's, at San Michele in Africisco and later at Torcello (47). Their methods resemble each other. Let us take the example which is best known to me personally.

Giovanni Moro, the mosaicist who had learned the craft in Milan with Raffaelli, began work in St. Mark's in 1822 and stayed until 1858. In 1845, his name is linked with the mosaics of San Michele Africisco. He also had the responsibility of restoring the mosaics on the west wall of the basilica in Torcello, where he worked between 1852 and 1856. Briefly, we know by examination *in situ* and archival research that Moro replaced important areas of the original mosaic at Torcello, using two methods: a) by completely redoing, after his own design, heavily damaged sections (such as the archangels of the Anastasis register (Fig. 10); b) by copying the original mosaics very carefully with new tesserae, following coloured tracings (47a). The commissions of the Academy of Fine Arts which approved this work had given him by contract the right to take away the old cubes of the mosaics he had replaced (48). Thus around 1850 it was still considered normal in official circles to have old mosaics completely remade with modern tesserae. Moro, a shrewd connoisseur and very greedy, abused this privilege by removing some heads which were very well preserved and replacing them with copies. He attached the originals to a new support and sold them secretly. Public opinion was shaken by this when it came to light a few years later on the occasion of an unconnected disgrace which removed Moro from his po-

sition as mosaicist of St. Mark's. As a result of all this, today we have the "advantage" of being able to compare the originals, which were found and put back in place, with Moro's copies, which have also been preserved. For the principal heads, Moro provided a very carefully done piece of work, copied stone by stone. They can in no way be compared to the mosaics that Moro executed "freehand", such as the Torcello archangels cited, whose shapes were purposely changed, it is said, so that Moro could make money on the gold background (49). The story of Moro at Torcello is interesting on more than one score and sheds light not only on the mosaicist but also on the authorities in charge of the mosaics. It is obvious that Moro was not overly conscientious. It is said that, in a deposition by one of his former apprentices, Moro is accused of sprinkling the mosaics of St. Mark's with water in the winter so that the frost would split them and he would, consequently, be assured of work. He was a poor draughtsman - see the Torcello archangels. He was, however, a connoisseur of beautiful pieces and, by necessity, a fastidious copyist. On the other hand, the commission of the Academy of Fine Arts had restoration criteria which were at the very least debatable, or rather, it had only very vague criteria. The commission's moral responsibility seems much more involved in this authorized destruction by a contractor who, in this case, was Moro, but who could have been another mosaicist with the same ascribed faults. Twenty years later, in Venetian circles interested in restoration a reaction was to break out.

After Moro was fired, the search for his substitute went on for several years until the firm of Salviati and Company successfully bid for the work and was hired. The firm worked at St. Mark's from 1876 through 1880 and at Torcello in 1872 and 1873 (50). The experience with the Salviati firm was hardly happier than with Moro. In general, the Salviatis worked in a careless way, using glass tesserae in loud colours, cut too large, and set without care. Even in the 1860s and 1870s, these mosaicists entirely replaced the old, deteriorated decorations with new mosaics (after cartoons, it's true). One of the most revealing examples of their method is provided by the row of Apostles in the Last Judgment, again at Torcello. Looking at the right side of this series, which is almost entirely redone, we note two essential things: a) a certain stylistic fidelity in the copies, maintained by means of drawings and coloured tracings made from the old mosaics that they destroyed and; b) the crude industrial technique of the contractor's work. The clearly visible seams between sections of the mosaic indicate that the Salviatis put the mosaic together in their laboratory and then attached it, when it was finished, to the wall. The results are me-

diocre. The rows of tesserae do not continue correctly, being unaligned at the junctures. Sometimes even the materials are different if the time between the completion of segments corresponded to the running out of the same stock.

The Torcello mosaics and their restoration by the Salviatis were included in an explosive argument in the early 1870s over the restorations in St. Mark's. Against restoration, on one side, was Alvise Zorzi, a friend of Ruskin and an intransigent defender of archaeological exactitude. On the other side was Eugène Viollet-le-Duc. In his argument, Zorzi cited, among others, the restoration of the mosaics of the Zeno chapel in St. Mark's (51). Viollet-le-Duc responded by speaking highly of the Torcello restorations which he had known *de visu* (52). We know them *de visu* too and can judge them for ourselves (52a).

While Zorzi in Venice was indignant over the renewal of the marble sheathing of St. Mark's, before the Salviatis began work at Torcello, the mosaics of Sicily, Rome and Ravenna were being diligently completed. In Trieste, the mosaics of the north apse of the church of San Giusto underwent a truly revolutionary restoration. They had narrowly missed falling into the hands of Moro who, in 1856, had proposed redoing them, and of the Salviatis who, in 1860, also wanted to remake them completely. Their actual restorer, Giovanni Righetti, built a supporting scaffolding inside the apse which conformed to the mosaic surface. This was done to avoid damage to the structure of the mosaic. Then he removed the supporting wall, beginning with careful demolition on the exterior of the building, and rejoined the mosaics from the back. Next, he removed the original bed of lime cement, replacing it with Portland cement and rebuilt the wall, all according to a method that he describes in detail in a small book (53). He did this work in 1866. In 1877-1878, the same methods were used in the restoration of the south apse of San Giusto (54).

Even though Righetti's method has imperfections, they are minimal when compared to what was being done everywhere else in Italy. Nearly a century later, the same method was to be used by Ferdinando Forlati on the large mosaic surfaces of the arches of St. Mark's (55).

In 1877, Zorzi proposed the creation of a commission for the conservation of St. Mark's. Its members would be artists and archaeologists who would direct the work of architects, artisans and workmen. Thanks to the initiative of a certain Pellanda, the mosaics removed from the Zeno chapel had been stored away in packing cases. Zorzi pleaded that they should be put back in place and opposed their remaking-restoration by the Salviati method currently used. To support his argument, Zorzi cited the opinion of Piero Saccardo, another defender of

the "archaeological" restoration of the monument: "if the mosaic is damaged in some parts, one must redo with scrupulous restraint only those parts which are damaged or missing and not take apart the whole composition in order to make it more beautiful and complete" (56).

The commission which Zorzi proposed was set up in 1878 to oversee the work in the basilica. One of its members, Saccardo, had the responsibility of organizing a special mosaics workshop for the basilica and drawing up its rules.

After the Salviatis left in 1880, Pietro de Vecchis, from Rome, managed the workshop. His work on the mosaics in the south gallery of St. Mark's was judged unsatisfactory and he was dismissed in 1883. Saccardo then himself assumed the directorship of the workshop.

Saccardo explained his principles of conservation and restoration in his book on the mosaics of St. Mark's cited above. He practised preventive conservation and used "all kinds of ways" to preserve the mosaics (57). He also defended the principle - applied "thank God, very rarely" - of removing mosaics when it is necessary to repair walls. Farther on, speaking of cases in which the mosaics have become detached from the wall, he praised the use of copper, bronze or iron nails which prevent the mosaics from falling and also explained the method of injecting pure liquid Portland cement behind the mosaic (58). Finally, while emphasizing its limitations, he took a stand for the composition of mosaics from the back (59).

The results of Saccardo's work at St. Mark's in the 1890s appeared periodically in the *Relazioni sui restauri eseguiti nella Basilica di San Marco di Venezia*.

The Regional Office for the Conservation of the Monuments of the Veneto was being organized at this time also. Its director, Federico Berchet, supervised the restoration of a great number of monuments and published their results in the annual instalments of *Relazioni dell'Ufficio Regionale per la Conservazione dei monumenti del Veneto*.

It was Berchet who was responsible for putting back the authentic Torcello heads in their original places in 1896-1897 (60). Besides replacing the heads, the mosaicists also consolidated, with cement, the tesserae detached from the mortar bed. Where paint had been used to cover gaps in the mosaics, it was removed and new tesserae were inserted. They also anchored the mosaics to the wall with nails. Reading reports from 1896-1897 of the operation, as well as closely studying the results, makes obvious its enormous difference in principles and execution, despite imperfections, from work of the past (61).

In the 1890s the Salviati name reappears when a certain Novo, who had been head of the Salviati workshops for twenty years, was en-

gaged to restore the mosaics at Daphni in Greece (62). It would be tempting, even possible, to imagine Novo as a young man on the scaffoldings of Torcello or St. Mark's. The restoration at Daphni, even if it is highly controversial today, is nevertheless a step forward when compared to work of twenty years earlier. All the mosaics were removed from the walls and put back in place on cement mortar. Only missing parts were remade and the few "before" photographs which allow us to judge the operation prove it (Figs. 12-16) (63). The most famous remaking is the completely invented head of Christ in the Doubting Thomas on the west wall of the south arm, followed by the remade heads in the Transfiguration in the north-west pendentive (Figs. 14-16). Finally, as a supplementary operation, Novo had to uncover the mosaics of the narthex (The Life of the Virgin) hidden under a layer of whitewash. He put them on new architectural supports to replace the old walls which were crumbling.

If Viollet-le-Duc had liked the restorations at Torcello, Gabriel Millet sang the praises of those of Daphni. It is true that the distance separating the two projects is incalculable. At Torcello the Salviatis destroyed the old mosaics and remade them according to cartoons (64). At Daphni, the old mosaics were preserved,

their cement bed renewed, and only those parts which no longer existed were invented "in the Byzantine manner". Curiously, Novo's style includes a checkerboard motif which he used for certain gold and silver surfaces, such as the crossed nimbus of Christ in the Baptism and in the Transfiguration. It recalls a similar motif observed by Bovini in the work of Kibel (65). Similarly, the improper and out-of-place use of transparent green and yellow tesserae at Delphi leads one to think that Novo had seen these colours in the original mosaics. They were abundantly used in the original Torcello workshop and he may have imagined he was "working in the old manner" by working according to his observations. The design of the remade sections shows that Novo very closely copied the style of the workshop whose work he wished to complete.

The last example I would like to present, to bring this discussion to the threshold of contemporary times, concerns the mosaics of the main apse of Torcello which had to be restored in 1919 (66). Because entire rows of stone were eroded and many mosaics were missing, the Cooperativa Mosaicisti di Venezia which was doing the work proposed to the Soprintendenza ai Monumenti that the entire mosaic be removed from the wall and redone in the laboratory.



Fig. 12 - Daphni, bema. Archangel Gabriel, state of preservation c. 1880 - 1890



Fig. 13 - Daphni, bema. Archangel Gabriel, condition in 1976



Figs. 14-15 - Daphni, nave. The Transfiguration, state of preservation c. 1880 - 1890



Fig. 16 - Daphni, nave. The Transfiguration, condition in 1976

The Fine Arts section of the Ministry of Public Instruction decided, however, that the work should be done *in situ*, with the removal of only certain parts of the decoration, of the gold ground and of the vegetation.

During work in the hemicycle of the apse, the mosaicists found an 18th century restoration in an important part of the row of Apostles. The Soprintendenza asked the Ministry - though expressing doubt - whether it was necessary to remove the restored mosaic and remake it completely. A commission of the Superior Council for Antiquities and Fine Arts went to the site and decided to retain the old restoration because: "if one were to remove all the mosaics formerly restored, it would effect a great part of the decorated surface".

Today, the list of mosaics on which work is being, or has been, carried out comprises all the monuments known to us. Whether it is

cleaning, maintenance or conservation, salvage of endangered parts, or protection against the possible effects of two world wars, the problems raised help us to know these mosaics better and consequently to study them better. The discoveries for the art historian during the last decades are innumerable. He starts from a far more solid documentary base in his studies before sketching out his syntheses. The modern study of mosaics begins with a chapter of pure archaeology which alone can spare the art historian a mass of useless speculation.

The problems raised today by the restoration of mosaics remain very complex, especially on the technical level. I feel certain that we will learn their current aspects here. My art-historical remarks stop here as I turn over the floor to the restorers.

The discussion which followed this lecture will be found on page 37.

Notes

1. E. Gerspach, *La Mosaïque*, Paris, n.d. In the same category but of less interest: G. Riolo, *Dell'artificio pratico dei mosaici antichi e moderni*, Palermo, 1870; A. Agazzi, *Il mosaico in Italia*, Milan, 1926.
2. P. Saccardo, *Les Mosaïques de Saint-Marc à Venise*, Venice, 1896.
3. The following works have good general bibliographies: H. P. L'Orange and P. J. Nordhagen, *Mosaik von der Antike bis zum Mittelalter*, Munich, 1960; G. Bovini, *Saggio di bibliografia su Ravenna antica*, Bologna, 1968, especially XIV, 5, "Restauro ai mosaici", p. 76. See also note 4.
4. Some of the better known titles are: I. Ciampini, *Vetera monumenta in quibus praecipue musiva opera sacrarum profanarumque aedium structura*, 2 vol., Rome, 1960-1969; G. B. de Rossi, *Mosaici cristiani e saggi di pavimenti delle chiese di Roma anteriori al sec. XV*, Rome, 1873-1899; J. Wilpert, *Die römischen Mosaiken und Malereien der kirchlichen Bauten von IV bis XIII Jahrhundert*, 4 vol., Freiburg, 1961; C. R. Morey, *Lost Mosaics and Frescoes of the Middle Period*, Princeton, 1915; A. Venturi, *Mosaici cristiani di Roma*, Rome, 1925; G. Matthiae, *Le chiese di Roma dal IV al X secolo*, Rome 1962; P. J. Nordhagen, "The Mosaics of John VII", *Acta Instituti Romani Norvegiae*, 2, Rome, 1965; S. Waetzoldt, *Die Koppien des 17 Jahrhunderts nach Mosaiken und Wandmalereien in Rom*, Vienna, 1964; W. Oakeshott, *The Mosaics of Rome from the Third to the Fourteenth Centuries*, London, 1967, with a bibliography; G. Matthiae, *Mosaici medioevali delle chiese di Roma*, 2 vol., Rome, 1967. This last work contains excellent photographs taken on the same level as the mosaics, technical notes on the condition of the mosaics, the results of extensive research in archives, as well as a detailed bibliography.
- 4a. The most complete record of restorations in Sicily are found in: O. Demus, *The Mosaics of Norman Sicily*, London, 1949, pp. 10-11, 29-36, 77-78, 108-112. For a recent analysis of the mosaics restored in the Palatine Chapel, see I. Beck, "The First Mosaics of the Cappella Palatina in Palermo", *Byzantion*, 40, 1979, pp. 119-164.
5. We have nearly complete scholarly documentation for most of the major Byzantine monuments of this period thanks to the Dumbarton Oaks Center for Byzantine Studies which, with a grant from the National Endowment for the Humanities, organized on-site research and photography in the Veneto, in Greece (Daphni and Hosios Loukas), and in Turkey (Istanbul, St. Sophia). Among churches, only Nea Moni in Chios has not yet been systematically photographed and studied. Smaller mosaics can be found *in situ* in Mount Athos (N. Kondakov, *Pamiatniki Christianskago Isskustva na Afone*, St. Petersburg, 1902) or detached from their original supports. For a detailed list of wall mosaics, see V. Glasberg, *Répertoire de la mosaïque médiévale pariétale et portative*, Amsterdam, 1974.
6. T. Whittemore, *The Mosaics of St. Sophia at Istanbul*, Boston, 1942, 3rd part, pp. 9-20 (the Zoë panel).
7. E. Diez - O. Demus, *Byzantine Mosaics in Greece. Daphni and Hosios Loukas*, Cambridge, 1931.
8. V. Lazarev, *Mozaiki Sofii Kievskoj*, Moscow, 1960; H. Logvin, *Keiv's Hagia Sophia*, Kiev, 1971.
9. A. Orlandos, *Monuments byzantins de Chios*, Athens, 1931, vol. II; G. Matthiae, *I mosaici della Nea Moni a Chios*, Rome, 1964.
10. O. Demus, *Die Mosaiken von S. Marco in Venedig*, Baden, Vienna, 1935.
11. The latest analysis, with bibliography, is I. Andreescu, "Torcello I, The Unknown Christ; II. Anastasis and Last Judgment: True Heads, False Heads", *Dumbarton Oaks Papers* (henceforth abbreviated as *DOP*) 26, 1972, pp. 183-223; *idem*, "Torcello III. The Relative Chronology of the Wall Mosaics", *DOP*, 30, 1976, pp. 245-335.
12. G. Gerola, "Il mosaico absidale della Ursiana", *Felix Ravenna*, 5, 1912, pp. 177-190; C. Ricci, *Monumenti: Tavole storiche dei Mosaici di Ravenna, LXXIV-LXXV, Basilica Ursiana*, fasc. VIII, 4, Rome, 1937.
13. V. Lazarev, *Mihajlovskie Mozaiki*, Moscow, 1966; *idem*, "I mosaici della chiesa dell'Arcangelo Michele", *F.R.*, 3rd series, 47, 1968, pp. 103-144.

14. M. Campitelli, "Note sul mosaico con i dodici apostoli di S. Giusto a Trieste", *Arte Veneta*, 12, 1958, pp. 19-30; M. Mirabella Roberti, *San Giusto*, Trieste, 1970.
15. The mosaics were published by G. Millet in *Le monastère de Daphni. Histoire, architecture, mosaïque*, Paris, 1899. The differences between the two main groups appeared after investigation from scaffolding in December 1976.
16. See note 4 above, pp. 21-40 (the panel of John II Comnenus).
17. See note 13 above.
18. See note 8 above.
19. In the last style at Torcello, see note 11 above, and in the mosaic of Murano, H. Rathgens, *San Donato in Murano und ähnliche venezianische Bauten*, Berlin, 1903.
20. O. Demus, *The Mosaics of Norman Sicily*, London, 1949; E. Kitzinger, *The Mosaics of Monreale*, Palermo, 1960.
21. P. Underwood, "The Evidence of Restoration in the Sanctuary Mosaics of the Church of the Dormition at Nicaea", *DOP*, 13, 1959, pp. 235-243.
22. Latest research and bibliography in R. Cormack, *Ninth Century Monumental Painting and Mosaic in Thessaloniki*, London, 1968, thesis manuscript.
23. C. Magno and E. Hawkins, "The Apse Mosaics of St. Sophia at Istanbul. Report on Field work carried out in 1964", *DOP*, 19, 1965, pp. 113-151.
24. See note 4 above.
25. G. Bovini, "L'aspetto primitivo del mosaico teodoriciano raffigurante la 'Civitas Clasis' in S. Apollinare Nuovo", *F.R.*, 55, 1951, pp. 57-62, ill.; *idem*, "Osservazioni sul frontone del Palatium di Teodorico figurato nel mosaico di S. Apollinare Nuovo di Ravenna", *Festschrift für R. Egger*, Klagenfurt, 1952, pp. 96-99.
26. O. Demus made this hypothesis in a public lecture at Dumbarton Oaks in May, 1977.
27. See note 11 above.
28. This last, known since 1482 for having restored mosaics, can be found under the name of Pietro Zorzi in the records of the Procuratoria. See Saccardo, *op. cit.*, especially pp. 38-39.
29. *Ibid.*
30. *Ibid.*, pp. 87, 219-220.
31. Archivio di Stato, Procuratoria di San Marco, Venice, *supra* Act. vol. 17, p. 93, *cf.* F. Ongania, *Documenti per la storia dell'Augusta Ducale Basilica di San Marco di Venezia*, Venice, 1886, p. 91; Saccardo, *op. cit.*, pp. 87, 206.
32. In 784, Hadrian I authorized Charlemagne to remove "palatii Ravennate Civitatis mosivo atque marmores ceterisque exemplis tam in strato, quamque in parietibus sitis", *cf.* Ph. Jaffe, "Monumenta carolina", *Bibliotheca Rerum Germanicarum*, 4, Berlin, 1867, reprinted Aalen, 1964, p. 268, and G. Bovini, "Antichi rifacimenti nei mosaici di San Apollinare Nuovo di Ravenna," *Corsi di cultura sull'arte ravennate e bizantina*, 1966, p. 75.
33. *Cf.* Simeonis Magistri, "Annales", *Corpus Scriptorum Historiae Byzantine*, Bonn, 1838, 691, p. 12; Georgii Monachi, "Vitae Recentiorum Imperatorum", *ibid.*, 843.13. See also C. Mango, *The Art of the Byzantine Empire, 312-1453*, Englewood Cliffs, 1972, p. 181.
- 33a. *Cf.* Michaelis Pselli, *Scripta Minora*, ed. E. Kurtz - F. Drexl, Milan, 1936, 299 in N. Oikonomides, "Some Remarks on the Imperial Mosaics of Saint Sophia," a lecture given at Dumbarton Oaks Center in 1975.
34. Bib. Naz. Marciana, Cron. Magno, Part. 5, It. Cl. 7, Cod. 517, c67t, *cf.* Ongania, *op. cit.*, p. 11.
35. For the background of this problem, with bibliography, see C. Cecchelli, "A proposito dell'abside Lateranense," *Miscellanea Bibliothecae Herzianae*, Munich, 1961, pp. 13-18.
36. C. Bertelli, "Un antico restauro nei mosaici di Sta. Maria Maggiore," *Paragone*, 1955, pp. 40-42.
37. See note 12 above.
38. *Die Friedenskirche bei Sanssouci: Ein Rückblick auf die ersten 50 Jahre ihres Bestehens 1848-1898*, Potsdam, 1898; L. Testi, *Storia della pittura veneziana*, Bergamo, 1909, pp. 57, 64, 81.
39. See the bibliography indicated in G. Bovini, *Saggio*, pp. 56-57.
40. Andreescu, "Torcello III", pp. 261-264 and Appendix A1, p. 277.
41. Saccardo, *Les mosaïques*, p. 106.
42. In fact, this method was still occasionally used in the 19th century, as in the mosaics in the vault of the south chapel — Saint Clement (Legend of Saint Mark) — by Pietro de Vecchis, see below, p. 28.
43. O. Powstenko, "The Cathedral of St. Sophia in Kiev", in *The Annals of the Ukrainian Academy of Arts and Sciences in the U.S.*, III-IV, 1954, pp. 18-20.
44. Mango, "Materials for the Study of the Mosaics of St. Sophia at Istanbul", *Dumbarton Oaks Studies*, 8, Washington, 1962.
45. Bovini, "Principali restauri compiuti nel secolo scorso da Felice Kibel nei mosaici di S. Apollinare Nuovo di Ravenna", *CCARB*, 1966, pp. 83-104.
46. Matthiae, *Mosaici medioevali*, especially the chapter "Note tecniche," pp. 397-400.
47. Bovini, "Principali restauri"; Matthiae, *ibid.*, p. 402; F. Deichmann, *Ravenna, Hauptstadt des spätantike Abendlandes, II, Kommentar*, 2nd part, Wiesbaden, 1976, pp. 38-39; Saccardo, *Les mosaïques*, pp. 234, 240.
- 47a. The curious Archangel Gabriel, as we see it today in Moro's restoration, his feet trampling the dragon while his lance pierces its tail, could have been influenced by the Archangel Michael of Potsdam-Murano. It is not impossible to imagine that it was Moro who removed the Murano mosaic around 1839. He would thus have been able to use his newly-acquired iconographical knowledge when he designed the Archangel Gabriel of Torcello about 1853.
48. Andreescu, "Torcello I-II", pp. 208-209.
49. *Idem*, "Torcello III," p. 270 and Appendix A5, pp. 289-294.
50. *Ibid.*, pp. 271-273 and Appendix A8, pp. 299-302; Saccardo, *op. cit.*, pp. 184-185, 204-205.
51. A. Zorzi, *Osservazioni intorno ai restauri interni ed esterni della Basilica di San Marco*, Venice, 1877, especially pp. 121-133; for an analysis of the prevailing attitude at that time, see S. Boscarino, "Il primo intervento della S.P.A.B. all'estero. Il problema dei restauri della Basilica di San Marco," *Psicon*, 10, 1977.

52. E. Viollet-le-Duc, "De la restauration des anciens édifices en Italie," *Encyclopédie d'Architecture*, 2nd series, 1, 1872, afterwards cited by A. Zorzi (see note 51 above) who reproduced it in its entirety. See especially p. 163 in the Zorzi reference.
- 52a. For those parts believed to have been restored by Salviati, see Andreescu, "Torcello III," pp. 271-272, with illustrations.
53. G. Righetti, *Su gli antichi mosaici della cattedrale di S. Giusto e particolarmente sui loro restauri*, Trieste, 1866.
54. Archivio Soprintendenza ai Monumenti Trieste, Atti S. Giusto, Mosaici, "Riferita intorno al lavoro di consolidamento eseguito dal Civico Ufficio delle Pubbliche Costruzioni al mosaico dell'altare di San Giusto."
55. F. Forlati, "The Work of Restoration in San Marco" in Demus, *The Church of San Marco in Venice*, DOS, 6, Washington, 1960, pp. 193-200, especially pp. 198-199; *Idem*, *La Basilica di San Marco attraverso i suoi restauri*, Trieste, 1975, *passim*.
56. Saccardo, report read at the Ateneo Veneto, July 27, 1864, cited in Zorzi, *op. cit.*, p. 144.
57. Saccardo, *Les mosaïques*, p. 127.
58. *Ibid.*, p. 178.
59. *Ibid.*, pp. 182-183.
60. IIIa Relazione annuale (1895) dell'Ufficio regionale per la conservazione dei monumenti del Veneto, Venice, 1896, pp. 186-187; IVa Relazione (1896, 1897, 1898), Venice, 1899, p. 139.
61. Andreescu, "Torcello III", Appendix A10, pp. 306-312.
62. G. Millet, *Le monastère de Daphni*, X-XI.
63. Photographies à l'Ecole Pratique des Hautes Etudes, Ve Section, Catalogue des négatifs de la Collection chrétienne et byzantine fondée par Gabriel Millet, new edition, Paris, 1955, pp. 95-97; Diez - Demus, *Byzantine Mosaics*, figs. 66, 67, 84-87, 89, 90, 98, 103.
64. And yet these practices had been systematically condemned since 1859, *cf.* Andreescu, "Torcello III," Appendix B, pp. 339-341.
65. See note 45 above.
66. Andreescu, *ibid.*, pp. 274-275 and Appendix A12, pp. 314-338.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions. We have, however, tried to record the essential points, thus showing the general direction of the discussion which followed the lectures of M. Lavagne and of Mme. Andreescu.

Sig. Urbani: It would be interesting to know the technique Mme. Andreescu uses to distinguish the restored parts of a mosaic. Is there some technical documentation of the problem of the division between old and new sections - or are there methods such as photogrammetry, or photographs made under special lighting, chemical analyses, etc.?

Mme. Andreescu: Many things can be determined on the scaffolding by a simple, meticulous, archaeological examination with the naked eye, but this subject, without question, should be much more discussed.

M. Bassier: In my present studies, I have made contact with the laboratory of physics and optics at Besançon. That organization has developed a method of handwriting analysis based on optical comparisons. By shining a laser beam through the hologram of a document, using Fourier's series they get an exact "ghost" of the handwriting. Thanks to this process, it is possible to distinguish between the true hand and the counterfeit.

If we consider the spaces between tesserae as writing, this method of optical comparison can be applied to their composition which is the expression of an individual technique. With this method, we hope to be able to objectively define the different techniques, the different ways of laying out or setting the tesserae, the work of this mosaicist or of that studio. If we add to the information obtained by optical comparison the analysis of the material making up the tesserae and the joints, the comparison of their process of alteration by time and the elements, their dating by thermoluminescence or by other means - when dating is possible and significant - we have sufficient facts to differentiate the original parts of a mosaic from ancient or recent restorations.

Sig. Urbani: Then the original form of each element could be found by comparing it to a series of standards?

Mr. Novis: We must be very careful to distinguish the work of one man from that of another. Many people could have been employed on the big mosaics, the main subjects done by the master and the borders by his helpers.

Mme. Andreescu: Sometimes it is possible to distinguish different hands working in the same studio. A good example of this is the mosaic of the Last Judgement at Torcello. There the authentic parts in the row of Apostles, on the left side, have been done, at least in regard to the feet and the green background, by two hands. From far away you can't tell the difference but it's very clear close up. The differences show that the surface to be decorated had been divided between two men of the same team who had received very similar training.

To return to Sig. Urbani's question, I would say that we can see the differences between the original and restored parts of a mosaic but it is not easy to express them in a descriptive and narrative way. I would like to show you the questionnaire used for the systematic analysis of a mosaic. A certain number of elements are examined, - technique, colours, materials, parts of the bodies, etc. If the examination is made according to this method, we can easily identify repetitions, and thus see whether the work was done by one studio only, or whether other studios or members of another team have collaborated on it. We have begun this in the Veneto and we have been able to test it in Greece and at St. Sophia. The Center for Byzantine Studies can furnish documentation on this subject.

At St. Sophia, in Istanbul, although only a few metres separate the mosaic of Zoë from that of John II, you can tell without a doubt that the techniques are different. The first was made between 1025 and 1045 and the other between 1118 and 1122. The colours and the textures of the vitreous pastes were cruder in the second period.

Sig. Urbani: The quality of the material then can give us useful clues?

Mme. Andreescu: The shapes of the materials, their thickness, their dimensions. etc., like the palette used, are important points which can be associated with certain periods and not with others. For example, examining on one hand some heads from the Torcello museum, and on the other some scattered fragments, stored in jars, which had been collected from the site, on the same island, where the church of St. John Baptist once stood, I felt that the two groups had nothing in common with each other. In fact, the loose pieces were similar to those of the Byzantine period found at Hosios Loukas, near Delphi, and Nea Moni, on the island of Chios, two churches for which we possess good documentation.

Sig. Urbani: Could we see one of these forms you use in your research?

Mme. Andreescu: I will bring you one Saturday. I have a question for M. Lavagne. Do you have a photographic technique which allows you to tell one period of restoration from another?

M. Lavagne: No, we don't. When it is possible, we obtain a photograph of the mosaic when it was discovered, before restoration. If we don't have one, we try to make up drawings showing the original parts. In regard to Mr.

Novis' remarks, I would like to emphasize that we are convinced that several workers, specialized in different parts, have worked on the same mosaic at the same time. For example, a Tunisian mosaic carries an inscription stating that a certain worker did the shadows behind the figures, another the white parts, etc.

M. Bassier: We must add to what has been said that statistical calculations permit the establishment of graphs showing the pattern of specific characteristics of tesserae whether outside their context or remaining in place in a mosaic. Thus we can clearly show the characteristic dimensions of the tesserae, their shapes, their statistical distribution by dimensions or by the shape of their faces, the characteristics of joints, of rows, the distribution of colours and of materials... We can make a series of specific diagrams of this or that part of a mosaic and compare them with those of other mosaics. Comparing the graphs proves that the tesserae are not arranged according to the Law of Great Numbers and consequently the mathematical functions they express correspond to particular techniques of specific artists, artisans, studios and ancient and modern restorers.

Sig. Urbani: Thank you very much. All of this has been very interesting. I think it is important to emphasize the value of a mathematical analysis of mosaic elements, especially in ancient works.

CONSERVATION PROBLEMS OF MOSAICS IN SITU

by Maria Luisa Veloccia

Translated from the Italian

The need to find a way to prevent the destruction of mosaic pavements has become extremely urgent. The problem has reached alarming proportions, not in regard to mosaics preserved in museums, but concerning those left *in situ* in the excavations. The problem there is dramatic and demands decisions which should never have to be made.

I speak from excavation experience in Ostia Antica where the problems appears on a macroscopic scale. Known mosaics in Ostia cover an area of 10,000 m² and, by the time the entire town is unearthed, the figure is likely to increase by half again.

Professionals recognize the importance of keeping mosaics in the place where they have been discovered. We have gone beyond the practice of transforming mosaics into just so many pictures to be hung on museum walls. Here it is that problems arise, if you can't reconstruct the

rooms which formerly sheltered the mosaics or enclose them in a series of sheds. There can be many reasons for this: costs, the size of the area to be covered, problems concerning the site itself, and inadequate knowledge of the height and roofing of the original buildings. The decision to leave mosaics in their original position, as we shall see later on, brings up a series of new problems tied to micro-biological infestation. This infestation must not be neglected, or regarded as a "lesser evil", given our limited knowledge in the area.

The causes of deterioration are ever-present and to some extent inevitable in ancient buildings and can easily lead to the total loss of the work. These causes can be reduced to three basic related and interdependent groups (Fig. 1). The groups concern the constituent parts of a mosaic, such as marble and stone tesserae, and mortar in the support, and, for simplicity's sake, we shall deal with them in the following manner.



Fig. 1 - A mosaic *in situ* in the process of disappearing because of sinking, calcination, gaps, and infestation by grass and algae

Disintegration of supports is caused by:

a) Decay of mortar: Effects the setting bed. It is due to sudden dehydration following excavation, to the thinness of the mixture and general aging. It is closely tied to plant infestation.

b) Breaking and sinking: The nucleus is the first to be effected. The causes can be due to the settling, often slow and gradual, of supporting structures; to the compacting of the underlying ground; to the collapse of beams, walls and roofing, especially vaults, all of which encourage fractures in and the sinking of the mosaic support. The support could have been already weakened by the penetration of woody roots.

c) Earlier restoration: Effect the setting bed. The difference in time, execution and in the quality of the mortar (providing little interpenetration) create sites which invite the rooting of weeds.

d) Atmospheric factors: Prolonged, driving rains, and especially frost, can also effect the nucleus.

Disintegration of tesserae is caused by:

a) Wear: This varies with the hardness of the tesserae. The maximum amount found so far is 0.5 cm.

b) Calcination: This is caused by old fires, when there were false ceilings made of cane, or modern fires, set during the summer to clear fields. The latter blacken and crack the tesserae.

c) Deterioration of the stone: Porosity of the stone, the lack of compactness in the mosaic as the tesserae flake away, pollution, and micro-biological infestation are the cause of this.

Micro-biological and plant infestation due to weeds, plants with bulbous roots, rhizomes, tap roots, shrubs, algae, etc. (Fig. 2), is caused by:

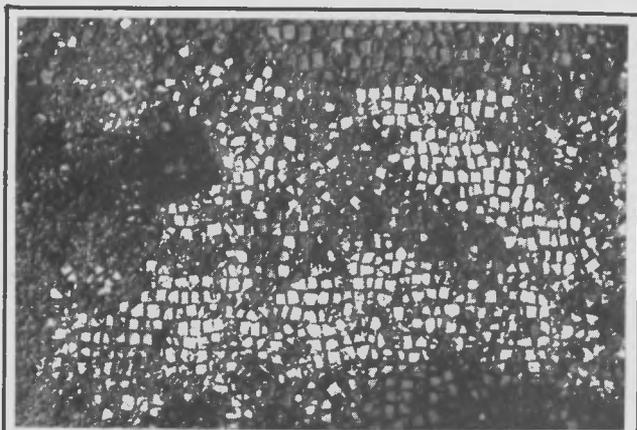


Fig. 2 - Pavement in a state of advanced decay because of the disintegration of the nucleus followed by the destruction of the setting bed and the breaking of tesserae by plant infestation

a) Seeding: This involves the setting bed. It is found on exposed mosaics, on fresh or old sand coverings, and on volcanic ash.

b) Lacunae: Filled with wind-borne soil, these act as veritable seeding beds.

c) Humidity: The infiltration and condensation of water in closed spaces favours algae infestations.

d) Lighting: Insufficient natural lighting because of small windows or a limited number, or artificial lighting under particular conditions.

e) Ventilation: None, rare, or only in particular directions.

Points (c), (d), and (e) apply especially to micro-biological infestations which generally appear in closed environments.

Now let us go back and develop these three groups.

Deterioration of supports

This is the most obvious, the most serious, and I would say the most decisive - certainly in its extreme form - step in the deterioration of mosaic pavements: The time it takes can vary according to climatic and environmental conditions (in some extreme cases, the time can be very brief, even only a few days). The amount of maintenance and foot traffic the mosaic gets also effect its rate of deterioration.

At first, the deterioration shows up as a kind of "elasticity" under loads and a yielding underfoot which is entirely abnormal for this kind of pavement. This is due to insufficient cohesion between the tesserae and their support. Formerly, at this stage, injections of liquid cement would be made to prevent the formation of bulges and cracks, plain signs of disintegration. This process had very mediocre results.

This process, even if it is sometimes used today because of economy and urgency, always gravely damages the mosaic. The process makes it almost impossible to correctly clean the back of the work as should be done when it is being removed in one piece. The cement, in fact, by penetrating between the tesserae and welding them to the nucleus, forms an extremely hard mass which, in turn, causes cracks in surrounding areas. This mass cannot be removed, even with mechanical means. Because of this, after the restoration has been completed, these areas of cemented tesserae stand out from the others, easily recognized by their arid appearance and lighter colours.

Suitable resins may provide the answer to the problem of arresting the deterioration of supports. Bearing in mind the requirements of good conservation, the qualities needed are stability under heat and light, almost total reversibility, easy application even in humid areas. The use of resins, however, remains an emergency measure limited in time and restricted to the weakened areas.

The moment these first signs of deterioration appear is the ideal time for restoration by detachment. Lacunae, cracks and displacements have, as a rule, not yet appeared and the lessened cohesion between the tesserae allows a complete brushing of the surface. This permits a better penetration of adhesive between the tesserae. In addition, only light, brief blows on the chisel are needed to detach the pavement from its support, thus diminishing the danger of breaking the tesserae or crushing those which are already damaged.

This first phase of deterioration generally appears shortly after the discovery of the mosaic. It is closely related to the state of preservation of the work, to its quality of workmanship, and very often, although indirectly, to its period.

A second phase follows with more striking manifestations. Disintegration and loss of parts of the mosaic begin. Cracks begin to form and rapidly grow in length and width. Swelling within the mosaic forces the tesserae to bulge upward. These breaks are almost always caused by the roots of plants which have worked their way between the tesserae and the support.

These phenomena are greatly accelerated in mosaics composed of big tesserae always of late periods, usually embedded in very dry mortar and, naturally, in the rare mosaics set in a quincunx.

Bulges are the most dangerous because they precede the expulsion of the tesserae themselves which happens unexpectedly and spontaneously if there is no conservation treatment, and brings about the loss of ever larger parts of the mosaic. Lacunae originating in this way are usually roughly circular and often keep the imprint of the lost tesserae for a while. With immediate, prudent action, the tesserae can sometimes be replaced, naturally following the design remaining in the setting bed.

This type of deterioration is still almost inevitable in our days. It is related to the nature of the work and to its vicissitudes and consequently it is at the top of our list. This type of deterioration, except perhaps in its first stage, is the result of a series of causes. The series begins, in the very rare case of a mosaic being discovered in a perfect state of preservation, with the sudden drying-out of the structure of the work which is already weakened by age. This drying is provoked by excavations which alter a state of equilibrium. The weakening is intensified by the settling which the mosaic has undergone over the ages.

Although we can't be precise about the length of time, because our observations are always made after the fact, the first stages of disintegration occur much more rapidly in late period pavements. In the later periods, the mortar was weaker and rougher. Deterioration shows particularly quickly when these late period pave-

ments are composed of tesserae of considerable size, some of which are cubes of 5 cm² a side. When they are that large, the binder between the rows doesn't have the strength to hold each tessera in place. Degradation is equally fast in places where, for climatic or environmental reasons, or because of their specific position (for example under a dripping fountain), the mosaics are subject to the erosion of steady driving rains or even brief and superficial frosts.

Older restorations are a weak point in the work because of little or no interpenetration between the drier nucleus slab and supports laid down in later periods. We see the same situation in fresco restorations when the work goes no deeper than the intonaco.

Fractures in the support are very frequent in heated rooms, in places where the floor beams have yielded, where vaulting or other heavy architectural elements have suddenly collapsed, or where settling has occurred. These fractures constitute the usual first step in the process of disintegration if it has not already been caused directly by the collapse or sinking of the pavement itself.

Climatic factors play a fundamental role in all phases of the disintegration of supports. Water in all its forms is the principal agent whether it be humidity by condensation, infiltration, stagnant water, or ice.

That is the general view, hardly comforting, of the situation. What are the immediate possibilities of a protective intervention that is relatively effective and inexpensive? We exclude cement injections, for reasons already given. On the other hand, because of technical considerations and their still high cost, epoxy resins cannot yet be considered available for large-scale use. We have also excluded immediate and total detachment. Aside from roofing over the mosaics, which has its drawbacks, there is another remedy which is temporary and seasonal and must be renewed every year. This is the application of a protective layer of sterile sand or *pozzolana* over plastic sheets carefully laid over the mosaic surface, which has previously been thoroughly cleaned and from which all plant life has been removed. This covering serves to keep the temperature of the mosaic relatively constant and to simultaneously block the infiltration of water and prevent the reappearance of plant growth.

Disintegration of tesserae

A basic cause of the destruction of mosaics is the degradation which the very material of which they are composed undergoes, whether that be stone, marble, ceramic or glass paste. The fragility of the last two creates a series of problems completely different from the others. But we will leave aside the problems of ceramic and glass paste tesserae because they are sel-

dom found in our area, at least in Roman pavement mosaics of the good period.

In the commonly employed stone tesserae, deterioration shows in surface porosity and scaling of the upper, external face. Inside the tesserae, there can even be fractures at the level of the support, especially if the support is particularly solid and the pavement is subject to heavy traffic.

It should be pointed out that this kind of damage is particularly frequent in polychrome mosaics, in which the difference in durability of the materials employed makes it almost inevitable. It is also very common in black and white mosaics where, to white tesserae of a very hard limestone material are added black tesserae of less durable sedimentary material.

This phenomenon basically depends on the type of stone employed. Only an exhaustive qualitative analysis of our mosaics would allow us to know beforehand where cases of this type of deterioration are likely to happen. At the moment, an investigation of this type would have only informative value because, until now, the removal and the substitution of cracked tesserae have been the only effective means of conservation.

All of these phenomena are accelerated by historical vicissitudes and the nature of the terrain. Particularly acid soil, rich in organic substances, or simply damp, aids the process of destruction. In the same way, a fire, whether it destroyed the building in ancient times, or whether simply a brush fire (Fig. 3) after the mosaic has been uncovered, can bring about the progressive deterioration of the tesserae even without calcination.

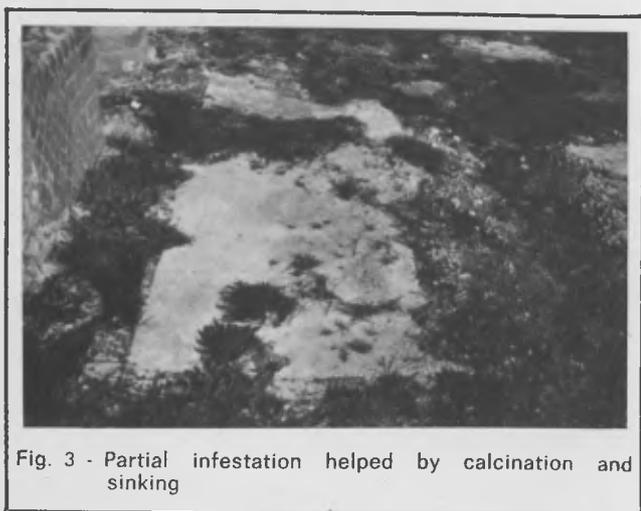


Fig. 3 - Partial infestation helped by calcination and sinking

In recent years atmospheric pollution has been added to what we might call the "traditional" causes of the disintegration of tesserae. The effects of pollution are so well known and cover such a wide range, involving historic mo-

numents in their entirety, that they shall not be covered in this brief analysis.

To avoid this slow destruction of tesserae, we must hope for the discovery of some substance which will increase their durability. We don't yet have a solidifying agent that is truly efficient and is easy to apply, which won't change the colours or the appearance of the work, which is reversible, and which works in the same way on stones and on binders.

Plant infestation

Up till now, we have examined the disintegration of mosaic pavements through the disintegration of their constituent parts. Now we are going to examine the principal cause of disintegration, we could describe it as external, which springs from the environment and not from the nature of the work: plant infestation.

For convenience, this can be divided into two major categories: plants which attack the nucleus and micro-organisms which attack the tesserae.

Each of these categories can be subdivided into other interdependent groups which concern the type of plant and the structural element it affects.

Grasses

This concerns infestation by weeds, roots, bulbs, rhizomes and tap roots, to cite the most common, which implant themselves in the mosaic surface and in the support. In all excavations in open country or in planted areas of some size, the wind spreads seeds of some plants which grow easily in calcareous or particularly poor soils. These plants grow in the fissures and lacunae of the mosaics, on deposits of decaying vegetable matter, or in disintegrated supports.

The growth of roots under the tesserae and along structural lines is aided by the accumulation of air-borne material. This rapidly builds up into a layer of relatively fertile compost in which biennials grow, preparing, in their turn, the layer of earth for more complex plants until the surface of the mosaic is finally covered by a mantle of vegetation. In such cases, the nearly total disintegration of the support rapidly reduces the pavement mosaic to a mass of small pieces of stone.

The list of infestants is rather long. It includes pasture weeds among which, noted for their diffusion and hardiness, are couch-grass, bromus, clover, the wild carrot, fennel, and bear-bine which, because of its abundant, widely-spreading roots, is one of the worst, most destructive plants and one of the hardest to eradicate.

It takes about thirty years for a mosaic to completely disappear under a covering of vege-

tation (Fig. 4). Under normal conditions, it should be possible to restore the mosaic during such a period of time. In specific cases, however, it is not possible especially if, as at Hadrian's Villa or at Ostia, the mosaics already excavated and left *in situ* cover more than 15,000 m². Thirty years are only enough to study and survey, but not restore, the discoveries of our predecessors.

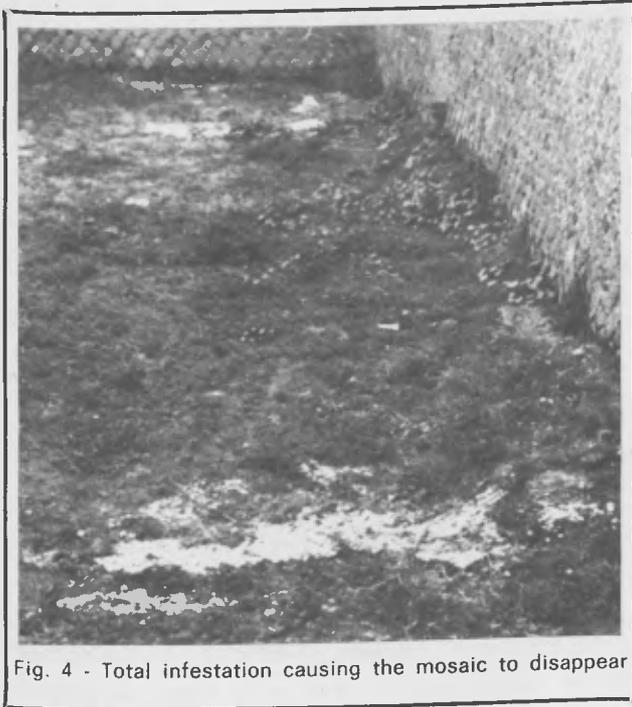


Fig. 4 - Total infestation causing the mosaic to disappear

Sometimes only two growing seasons are enough for the destructive spread of roots. These are the ones that cause the most important damage because they cause a detachment of the tesserae, wherever the roots have penetrated, spreading out from the original plant. When tough plants, or bushes with woody roots get into the cracks, the lacunae of the slab, or into gaps in the walls, the mosaic surface quickly cracks and bulges (Fig. 5).

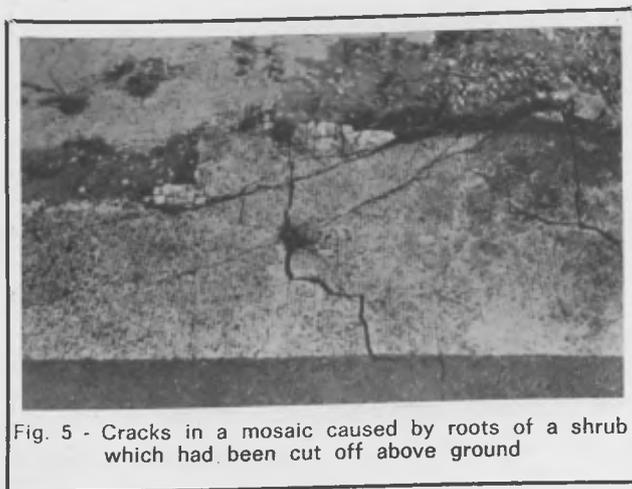


Fig. 5 - Cracks in a mosaic caused by roots of a shrub which had been cut off above ground

How then can we intervene to limit, if not avoid, this kind of damage?

In the first place, mosaics need to be cleaned constantly. But however constant and careful the cleaning, it is almost never sufficient to prevent the intrusion of roots and the subsequent break up of the supports. Removing the plants by hand doesn't prevent them from springing up again because only the part above ground has been destroyed. Furthermore, pulling the weeds out is only possible at the beginning of the infestation when it is limited to a few clearly visible sporadic tufts. Besides, there's always the risk in this process of pulling out tesserae caught in the roots (Figs. 6, 7). Chemical herbicides provide a temporary solution to this problem. They completely destroy the mantle of vegetation including its roots, and allow the removal of plant debris and the recovery of the mosaic without disturbing its texture, even when the support is nearly destroyed.

Among the many herbicides on the market, we need to choose those which destroy the plants' roots, which do not spread through the soil, which act during the winter, thus permitting removal the following summer, and which do not seem to leave salt deposits. They must also be easy to use and be absolutely guaranteed non-toxic to humans and animals. Herbicides which simply dry up the exposed part of the plant and do not interfere with the vegetative process are entirely inadequate.

Herbicides become indispensable when mosaics are found close to the surface or when, for various reasons, protective sand layers have not been removed for several years and the infestation has been able to reach the mosaic. In the particular case of Ostia, just as an example, the extent of the mosaics, the excavation problems, the disturbances of the war - the consequences of which are still, unfortunately, felt - and the state of conservation have forced us to make on-the-spot decisions regarding restoration and resetting pavements as well as in the seasonal operation of covering the mosaics in winter and cleaning the mosaics the rest of the time. The use of chemical herbicides of the hormonal type seems to have fully solved the problem of weeding, as long as you keep up a continual campaign. It will uncover all the mosaic and marble pavements and allow a survey of them.

Micro-organisms

This second category of plant infestants must be examined separately because its characteristics are practically the opposite (Fig. 8) of those shown by weeds, and because it is less widespread. We must also bear in mind that these remarks are only preliminary because our observations and experiments are barely past the initial stage.



Fig. 6 - Infestation limited to the gaps in the mosaic (note Fig. 7)

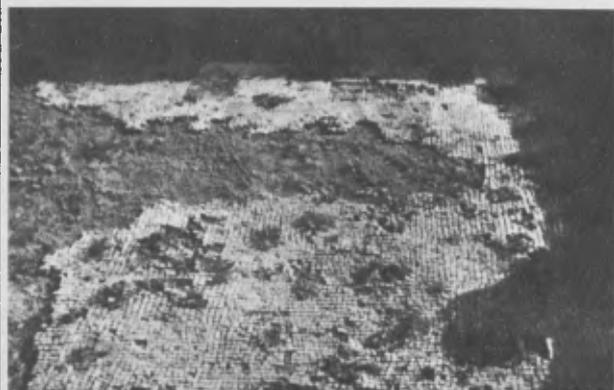


Fig. 7 - Condition of the pavement after removal of the grass. The tesserae are all clearly detached

Algae, which are not yet completely classified, attack mosaic surfaces from the edges of the tesserae. They get into the grouting, which is usually damper, covering it with a grey-brown film, tending toward green in the better-lighted areas, tarnishing the colours and obscuring the

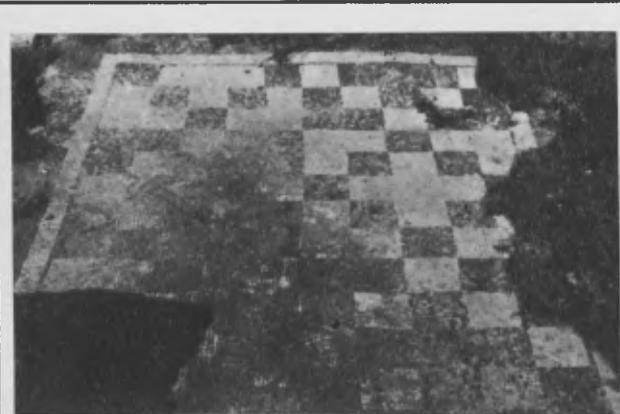


Fig. 8 - Varied development of lichens on a partly shaded pavement

design. At the moment, we can't say how they attack the surface of the stones although in all the cases we've studied up till now the tesserae, after being attacked have become much more porous, even when the algae leave the supports intact. Algae grow only on undisturbed pavements and prefer closed or covered places where there is little or no ventilation and the lighting is equally bad (Fig. 9). Yet we have recently observed that colonies of green algae can flourish in particularly humid conditions even in open, ventilated areas. As soon as a roof has been installed, a colony of algae usually appears. Its development is always rather slow and cyclical, growing faster in late autumn and the middle of spring.

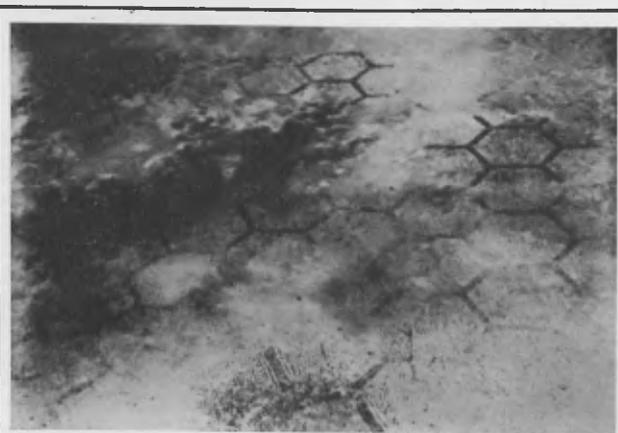


Fig. 9 - Development of algae on a mosaic in a damp and poorly-lighted place

Experiments made so far, in collaboration with the Istituto Centrale del Restauro, indicate that algicides (merthiolate) seem to be effective for about a year and a half, provided that the algae are alive (Figs. 10, 11). We can't make any suggestion for algae in the dormant stage or for lichens which don't seem to react to the sub-



Fig. 10 - Mosaic in a dark and damp place before treatment

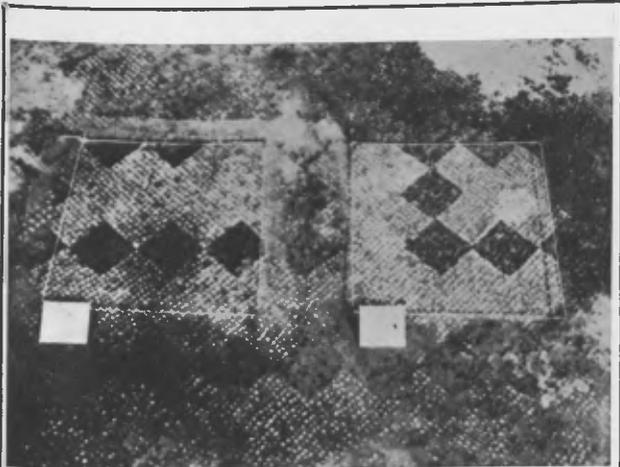


Fig. 11 - Mosaic after chemical treatment

stances we have used. But we have not yet begun systematic experiments.

From this necessarily brief examination of the causes of deterioration and of their consequences, we have seen that the only restoration practice which can definitely stop these processes appears to be detachment of the pavement and placing it on a new support. All the other interventions are only preliminary or temporary, dictated by urgency and the absence of other means. How valid is the detachment method? From a critical point of view, it is long and costly, final, in certain aspects, irreversible, and very debatable.

By experimenting with new substances and trying new techniques, we are trying to find a means of conserving mosaics at their place of origin, without detaching them, by strengthening the supports and removing plant infestation. The answer to this problem will be found in the most rigorous experimentation and research, which can only be done through equal and friendly collaboration between experts in archaeology and the applied sciences.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions. We have, however, tried to record the essential points, thus showing the general direction of the discussion which followed Signora Veloccia's lecture.

Mr. Feilden: We have only a little time left, perhaps enough for one or two questions.

M. Guilly: Madame, what experience have you had with lichens?

Signora Veloccia: There are very few lichens at Ostia. We have them only in places where organic pastes were used. I'd like to bring up this problem again with the Istituto Centrale del Restauro and with Dottoressa Giacobini of the micro-biological laboratory there. We haven't had much success in treating lichens.

Sig. Villa: The I.C.R. is conducting some experiments now which will end in eight months. In regard to lichens, they create special problems and they're more difficult to treat than

algae. The products we've tested give some results but they require a clean-up afterward. Lichens with leaves, however, should disappear after a short while. We'll get the results of the experiments next June.

M. Ghouj: I've heard objections against the use of cement and lime. It seems that Italy uses them. What do you think of using cement and sand? Is that bad for mosaics?

Signora Veloccia: There's no doubt that mosaics are damaged by the use of cement because of the fact that you can't do a complete cleaning of all the elements. Furthermore, even if cement will preserve a mosaic for a very long time, it's extremely unaesthetic. A mosaic on a cement support seems lifeless. Its colours are faded and consequently they seem less attractive than those on a mortar support.

Mr. Feilden: I am grateful to Madame Veloccia for this diplomatic reply. Experts coming to ICCROM always seem to agree that you should not use cement.

SOME EXPERIMENTS IN THE USE OF EPOXY RESINS FOR THE IMPREGNATION OF THE NUCLEUS

by Giuseppe Marinelli

Translated from the Italian

Introduction

The fundamental problems confronting the restorers consist of partially or totally rebuilding original structural characteristics and protecting the damaged object in order to delay future deterioration. Stone, mortar and brick are construction materials which have common characteristics. Therefore, a common solution may be sought for their conservation. In effect, it is advisable to use just one product in the treatment of these construction materials. But what should be the principle characteristics of such a product? In order to answer this apparently simple question, we might recommend the following list of characteristics:

- low viscosity, permitting deep penetration of the product;
- good hydrophilic qualities, allowing absorption by damp materials;
- sufficient chemical resistance, considerably superior to that of the material being treated;
- high mechanical resistance in order to reinforce the material being treated;
- no tendency to clog pores, allowing the material to breathe;
- little yellowing upon exposure to daylight;
- low tendency to alter the colour of the material being treated;
- toxic qualities fully known so that users can take the appropriate protective measures.

Numerous chemical products (organic and inorganic) have been tried and recommended as strengthening materials. During recent years the resins and plastics industry has produced interesting synthetic materials. These epoxy resins are of particular importance. Various experiments in impregnation, consolidation and protection of construction materials have been made with them. We also know that for numerous applications in the field of impregnation, consolidation and protection of construction materials, epoxy resins have been used as basic components.

Why have these resins, widely used for many years to resolve difficult and important problems in various branches of industry and especially in civil engineering, attracted the attention of those involved in restoration research as well as technicians in the field? This interest is sufficiently justified by their specific properties.

Epoxy resins in the building of the support

For a long time we have been applying the technique of detaching and relaying mosaics on a bed of stratified fibreglass impregnated with resin. This technique calls for the application of a reversible adhesive on the visible surface of the mosaics, already cleaned and scraped and cementing a flat, strong fabric to it.

The detached mosaic is then transported to a restoration workshop.

There it can be placed on a new support formed by a stratified panel of fibreglass and resins. When this hardens, the cloth which covers the visible surface of the mosaic is removed.

The panel obtained is light, easy to carry, and the hardened epoxy is extremely stable, considering its size and its resistance to chemicals and humidity.

Epoxy resins in the impregnation and consolidation of the nucleus

Numerous experiments have been made using XG40/XG41 and XG40/XG42 to strengthen buildings and monuments, all of which have proved highly successful. We can cite for example, the Monastery of Saint Benedetto of Bergamo (sandstone, brick, mortar), the Tower of Cremona (brick and mortar), the Provincial Government Palace at Bergamo (sandstone), the Rossini Theatre of Pesaro (wooden structure), the Gates of Rome (wood), etc. These experiments were carried out by specialized personnel.

Following these impregnations and consolidations of stone, mortar and brick, we considered

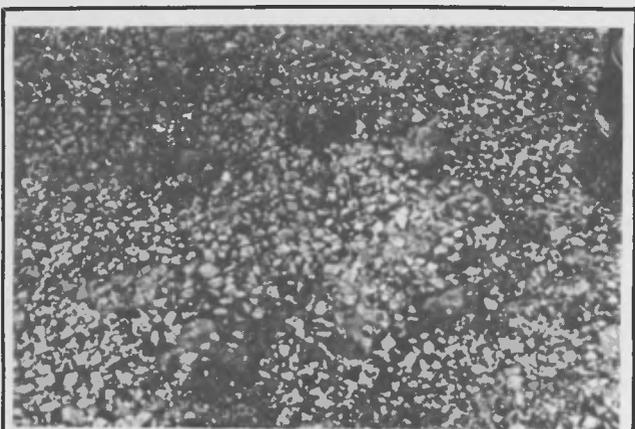


Fig. 1 - Pavement of white agglomerate before treatment



Fig. 2 - Section of pavement in the process of treatment

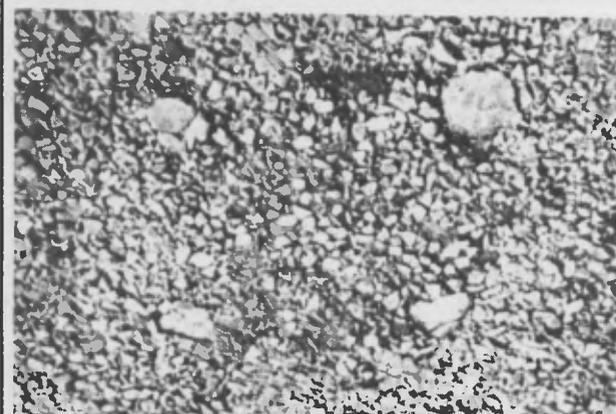


Fig. 3 - The same section of pavement after a year. This area is still well preserved.

using the products XG40/XG41 for strengthening the nucleus of mosaics.

One particular problem arose two years ago in the Roman city of Luni where the material from the excavations deteriorated at exceptional

speed as soon as it was brought to light—notably one section of pavement made up of white and coloured marble tesserae, held together by a bed of soft lime mortar.

This type of pavement does not contain decorative figures and therefore it is more an aggregate than a mosaic. Nevertheless, the problem of the consolidation of the nucleus may be considered identical to that of an actual mosaic.

The Centre for Studies of the Causes of Deterioration and Methods for Conservation of Works of Art 'Gino Bozza' of the CNR was given the responsibility of studying the conservation of the objects discovered.

In cooperation with CIBA-Geigy, numerous applications of XG40/XG41 were made *in situ* and on laboratory samples in order to evaluate the possible employment of this product in strengthening the pavements already brought to light and those recently excavated (Figs. 1-3).

Both laboratory tests and those carried out *in situ* proved the effectiveness of the treatment.

One might state:

- A) The penetration of the product XG40/XG41 is excellent and that a sample was absorbed throughout a depth of several centimetres.
- B) If one removes the excess resin with a solvent (for example methylacetone) from the surface of the tesserae before the resin hardens, practically no colour variation occurs even after prolonged exposure.
- C) Consolidation can be considered good: in effect, the materials that were loose before treatment were strengthened and could even be mechanically treated in order to give them a specific form.
- D) This consolidation is permanent both after the accelerated aging cycle appropriately chosen for the study and after exposure to air, even in particularly unfavourable conditions (for example the material permanently semi-immersed in water).
- E) The treatment does not obstruct but only lines the pores, thereby improving the product's resistance to water. At the same time, it does not reduce the possibility of exchange of gaseous elements between the core of the material and the atmosphere.

For all of these reasons the penetration of epoxy compounds was considered successful and was used for the consolidation of archaeological material at Luni.

The discussion which followed this lecture will be found on page 52.

THE REMOVAL OF WEEDS FROM OUTDOOR MOSAIC SURFACES

by Alberto Villa

Translated from the Italian
by Cynthia Rockwell

Archaeological structures are constantly endangered by a large variety of plant forms, ranging in size from trees down to tiny algae.

This is often one of the principal causes of the decay of ruins, especially if they are composed of structures which are already collapsing or, like ancient mosaic surfaces, composed of small tesserae held by binders which frequently have lost most of their consistency (Figs. 1, 2).

With regard to the problem of the conservation of outdoor mosaic surfaces, the presence of weeds can clearly cause permanent loss for the reasons given below:

Plant roots, which are often very thick, and up to several metres long, "digest" the binders, causing dispersion of the tesserae.

Water penetrates into the cracks caused by the chemical and mechanical action of the roots and freezes in winter time, causing further disruption of the mosaic surfaces.

Over a period of time, mosaic pavements can be completely over-grown by vegetation which obscures their legibility.

Aside from this kind of macroscopic damage, there is also damage from moss, algae and lichens which can be equally serious to different extents. In addition to corroding and staining the tesserae, these organisms, notably lichen, can uniformly cover the mosaic surface, causing corrosion damage or at least micro-perforations of varying gravity.

It has always been deemed necessary to use different types of manual and mechanical weeding to eliminate plant infestations.

However, it has been obvious for some time that these systems do not guarantee truly positive results, due to the following factors:

The roots of living plants resist extraction and considerable mechanical force is often required to pull them out. This can cause quite serious damage to the entire foundation of the mosaic itself. Considering that such operations must sometimes be repeated several times a



Figs. 1, 2 - Examples of damage caused by the presence of weeds

year, it is easy to imagine how much damage this type of maintenance can produce.

Root fragments remain in place and the plants reappear.

It is difficult to clean up inaccessible areas.

In contrast, chemical herbicides, aside from brilliantly avoiding the technical problems mentioned above, also save a great deal of time and labour in that a simple application eliminates the weeds without their having to be removed.

In a simplified form, we can indicate the typical cases where chemical herbicides become indispensable:

Pre-excitation disturbances over areas where especially delicate ruins, such as mosaics, are expected to be found.

In fact, it is easy to imagine the damage which could be caused, even before excavation, by pulling up living plants with their roots deep in a mosaic pavement.

Preventive work on mosaic surfaces during excavation. During excavation projects, a good deal of time often goes by before it is possible to consolidate or detach the mosaic surfaces that are brought to light. During this time, weeds can begin their destructive action.

The immediate use of chemical weed-killers can completely preserve the ruins from the effect of natural seeding before conservation work begins.

Maintenance work on mosaic surfaces kept outdoors. Especially in the case of large archaeological areas where it is virtually impossible to maintain a continuous level of restoration works, sequences of strong temperature changes, meteorological action, and sometimes

pedestrian traffic, produce numerous fissures in which all kinds of vegetation can take root.

Under these circumstances, intervention with chemical herbicides can prevent the damage, which may be light at the outset, from accelerating into something quite serious. These dangers, however, are clearly even greater in the case of mosaics in archaeological areas which have been excavated and then abandoned (Fig. 3).

In such a case, careful disinfestation is required before any new work is undertaken (Fig. 4).

The use of chemical herbicides which have been mentioned so far must never be attempted by an amateur. Selection of the proper active elements, dosages, and the most convenient application techniques are vital factors in the success of the operation and in protecting the ruins from exposure to dangerous substances.

It is opportune to examine - though only in passing, given the informative nature of this paper - the categories in which weed killers are grouped. There are two classifications.

The first category (modes of action) includes the following types of weed-killers:

Anti-seedling (act in the initial phases of germination and sprout growth).

Contact (act directly on the aerial organs of plants, with immediate effect).

Penetration - which can be further divided into two categories:

— by root absorption (when they act principally through the root);

— by foliage absorption (when they act principally through the foliage).

In the second category (mechanisms of action), weed-killers can be divided as follows:

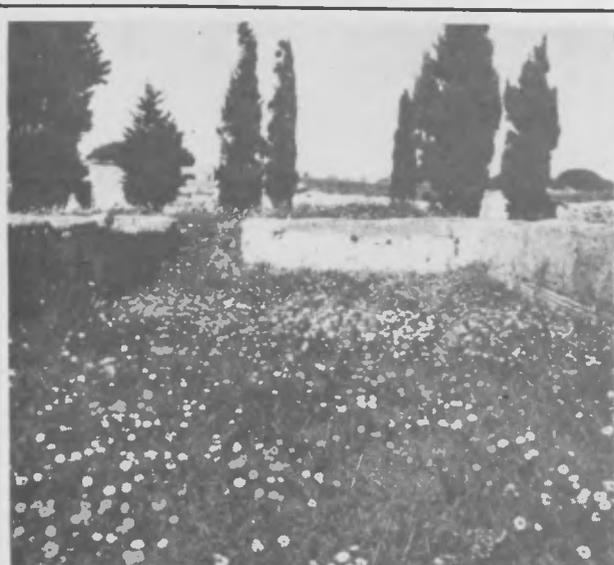


Fig. 3 - Condition of a mosaic pavement before treatment



Fig. 4 - The same pavement 60 days after application of chemical herbicides

- Germination inhibitors
- Auxin or auxin-like substances (hormones)
- Photosynthesis inhibitors
- Respiration inhibitors

We have simply listed the categories of this second group because a more thorough exposition would lead us into technical discussions which seem beyond the scope of this presentation.

Let us examine the qualities which are indispensable for a herbicide:

— Absence of any physical or chemical action, direct or indirect, on the ruins being treated. The weed-killer must be colourless, transparent and leave no stable inert residues after application, or at least none which cannot immediately be dispersed by rainwater. Therefore we must exclude any formula which is coloured, oily or which leaves permanent traces of its use.

— Chemical neutrality.

— Non-toxicity for humans, domestic animals and wild animals.

— The widest possible control of the vegetation infesting the areas to be cleared.

— Absence of material which might pollute surface or sub-soil water in the area being treated.

— Governmental registration at the agencies in charge of public health.

— Stability of the active base, so that it remains within the limits prescribed for the application. There should be no lateral seepage which might extend the herbicidal action to areas which are not meant to be disinfested (Fig. 5).

— Eventual degradability through the action of micro-flora in the ground.

After lengthy experimentation in disinfestation of historic sites conducted by the Microbiology Laboratory of the Italian Central Restoration Institute, and taking into account the results obtained over years of practical and experimental work, we can say that the following herbicides are to be preferred: those of the penetrating type, absorbed through roots or foliage, which inhibit photosynthesis. These meet all the requirements we have listed so far.

Obviously, for horizontal mosaics such as pavements, herbicides based on root, or mixed absorption are preferable because the force of gravity keeps residual amounts of root absorption formulae in the mosaic binding material (Fig. 5).

In contrast, for vertical mosaics, herbicides based on foliage absorption are preferable. The formula need only come into contact with the foliage and is then carried inward, thanks to the plant's vascular system, to every part of the organism, down to the roots; once the latter are dead, they generally dissolve without trace.

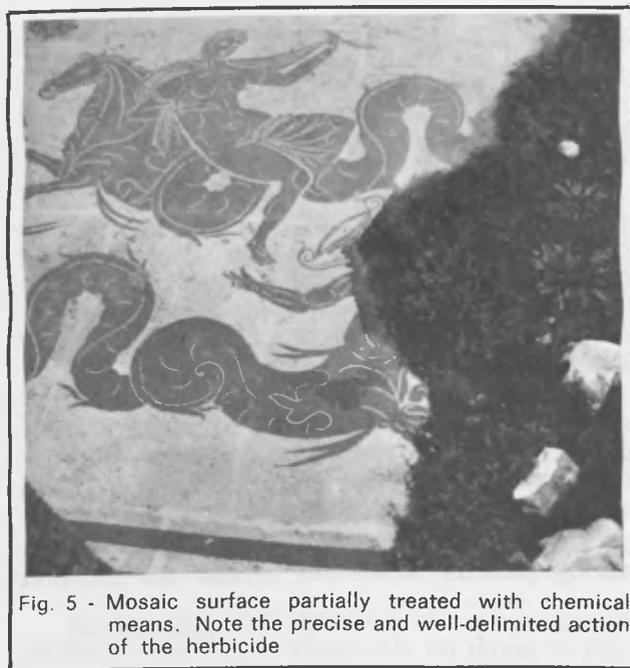
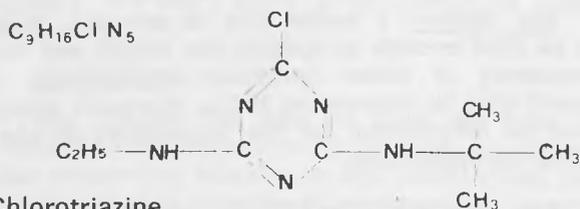


Fig. 5 - Mosaic surface partially treated with chemical means. Note the precise and well-delimited action of the herbicide

Larger roots, after drying out, can easily be pulled out without damaging the ruins, for they have greatly diminished in size.

The two active principles given below are particularly employed in the category of herbicides we have indicated. They belong to the chemical group of triazine:

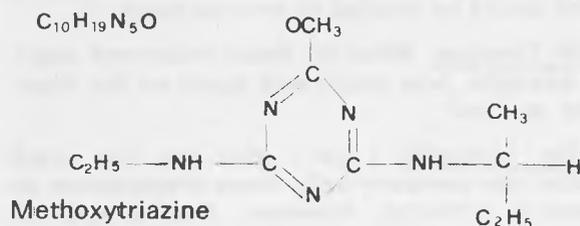
2-chloro-4-ethyl amino-6-tert-butyl amino-s-triazine



Chlorotriazine

- solubility in water, at 20 °C, equal to 8.5 p.p.m.;
- neutral chemical reactivity;
- stable in the ground;
- principal action through root absorption;
- effective against a vast range of plants.

2-methoxy-4-ethyl amino-6-sec-butyl amino-s-triazine



Methoxytriazine

- solubility in water, at 20 °C, equal to 6.20 p.p.m.;
- neutral chemical reactivity;
- principal action through foliage absorption;
- effective against a vast range of plants.

The triazines we have described, aside from their action on the majority of plants found in ruins, also have the advantage of very limited mobility in the ground. This characteristic makes it possible to use them within strictly defined limits, with no damage to adjacent areas or to the surface water.

Sixty days after application of these herbicides, it is possible to see the full effect of their action; after this time one can judge whether later touch-ups are needed on plants or in zones where the herbicidal action was weaker.

The best time to apply these herbicides is during periods when the weeds are growing

(spring or autumn). The choice between these two periods can be made on the basis of the behaviour of the normal climate in the operative zone (average rainfall, temperature, etc.).

The herbicides commonly used have not always been fully effective against moss, algae and lichens. In order to resolve this problem, the Italian Central Restoration Institute has carried out a long cycle of experimentation with different active principles. This research is nearing successful completion and the results will be made available as soon as all the experiments are finished.

In conclusion, one can state that chemical treatment of infestation is a truly useful and irreplaceable instrument, which makes a rational contribution to the preservation of outdoor mosaic surfaces from attack by weeds - attacks which are among the most active causes of progressive decay.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions. We have, however, tried to record the essential points, thus showing the general direction of the discussion which followed the lectures of Sig. Villa and Sig. Marinelli.

Sig. Urbani: I would like to ask Sig. Villa to be kind enough to specify the length and the frequency of these herbicide applications. It would also be interesting if Sig. Marinelli would give us information on the application of chemical compositions.

Sig. Marinelli: The solution is applied with a paint brush. This allows you to feel the surface of the mosaic and measure the speed of absorption. This treatment should be continued until the desired degree of penetration has been reached.

Sig. Paparatti: What is the reversibility of the resins?

Sig. Marinelli: Heat-hardened products are not reversible. A complicated process using flame would be needed to remove them.

M. Lavagne: What do these treatment cost? For example, how much was spent on the treatment at Luni?

Sig. Marinelli: I can't give you the exact details; our company sells these preparations as chemical products. However, they're not ex-

pensive, about Lit. 4,000 a kilogramme. To this should be added the cost of applying it.

M. Novis: I've attempted treatments like this for years. How can the solution penetrate very compact mosaics? I have used it on the backs of mosaics but it has never penetrated to their surfaces. Would low viscosity be enough for penetration?

I have another question. In another pavement, the stones became purple. This might have been because of contamination by sea water, but in any case those mosaics had to be destroyed.

Sig. Marinelli: Although I'm not a restorer and I have had hardly any experience in that field, I believe that impregnation is only possible when there is a surface able to absorb the product. A very compact surface would make penetration from above difficult. Consequently, only the less compact mosaics can be treated in this way.

In regard to the change in colour, there's a large variety of epoxy softeners and some of those resins could have this effect. The amines, for example, known for their colour strengthening properties, especially in food colourings, could be the reason for the change. That might be the explanation of what happened.

M. Bassier: If you will permit me. I would like to make two remarks.

First, one only impregnating product doesn't exist, however excellent it may be. The impreg-

nating material should be chosen according to the nature and the characteristics of the support, of its changes, and the causes of these changes. The composition of the nucleus and the rudus are not always physically the same. We must bear in mind many different factors and make experiments before beginning with impregnations.

Impregnations are operations with uncertain results, hazardous, and to be avoided as much as possible. One product alone can't resolve all problems.

Secondly, if the nucleus is changed, it's due to old, contemporary or permanent reasons. Fissures and micro-fissures are only surface phenomena. It could be dangerous to use products which seem to solve obvious problems, the results of hidden stresses, and thus to camouflage the real reasons of the trouble.

Sig. Urbani: What kind of stresses?

M. Bassier: Chemical, physical and particularly mechanical stresses, differences in the rate of settling, the pressures of expansion and contraction, and the dangers of any form of humidity, especially when it is blocked by an impermeable layer.

Sig. Urbani: I don't understand. Are you questioning the value of any kind of impregnation?

Mr. Bassier: The impregnation of the nucleus seems a vary delicate, hazardous operation, when you can't control all the factors, especially humidity.

Sig. Torraca: I would like to ask Sig. Marinelli some questions on the formula for solidification. You have said there are no by-products but the formula shows that some OH groups remain. Could they react with the solidifier and form water? On the other hand, if they don't react, the final product would be absorbent.

Sig. Marinelli: The solidification reaction concerns only the epoxy groups. The OH groups

are distributed in the polymer and don't have absorbent characteristics. Polymer is tridimensional and consequently the OH groups are captive and can't draw water from the air. These OH groups are probably most responsible for the adhesive properties of epoxy resins.

M. Ghouj: In Jordan, we use lime and cement under mosaics. Would you recommend the use of varnish to protect them from reseeding after herbicides have been used?

M. Villa: Any protective film can be applied after the herbicide. Varnish should be used first. I see nothing against it.

Sig. Torraca: What kind of varnish do you use?

M. Ghouj: A white or colourless varnish so as not to effect the colours in the mosaic.

M. Bassier: I'm opposed to using varnish on mosaic surfaces, especially on those *in situ*, for two reasons:

First, sealing humidity into the skin of the mosaic speeds up physical and chemical changes.

Secondly, because varnish changes the look of the surfaces of the tesserae. It's enough to compare a piece of varnished marble with another, clean, piece to understand the aesthetic danger.

Sig. Urbani: I can understand your point of view. Nevertheless, perhaps a light coat would act like a micro-crystalline wax and protect the surface. We don't know what varnish is used; is it gum-lac?

M. Ghouj: Yes.

Sig. Urbani: For lack of time, we have to close the discussion here. It certainly has shown that preserving mosaics *in situ* poses great problems and that considerable research is needed in this field.

THE CLEANING, CONSOLIDATION AND TREATMENT OF WALL MOSAICS

by Lawrence Majewski

Original text in English

The techniques of construction of wall mosaics and the conservation of murals made from tesserae as herein discussed are based on the personal observations of the author during years spent as the Deputy Field Director of the Byzantine Institute of America in Istanbul from 1956 to 1960 and as Chief Conservator of the Archaeological Exploration of Sardis, Turkey, from 1964 to the present. During these years of field activity the conservation work on wall mosaics was carried out in the following monuments in Istanbul: St. Sophia, Kariye Djami (Church of Our Saviour in Chora), and Fethiye Djami (Church of St. Mary Pammakaristos). A number of conservators and local technicians, notably Ernest Hawkins, Carrol Wales, and Constantine Tsoulos, participated in the work while the art historian and architect, Paul Underwood, was the field director of the Byzantine Institute. At Sardis work on mosaics was principally on floor pavements in the Great Synagogue of Sardis, the Gymnasium complex, and the sectors designated Pactolus Cliff and Pactolus North. However, in each of these sectors small frag-

ments of wall mosaics were excavated and on some masonry walls mosaic setting beds remained *in situ*.

A wall mosaic may be defined as a decoration executed on a vertical or vaulted surface with tesserae or cubes of natural stones, coloured and nearly clear glass, gilded glass, occasionally glazed ceramics, bricks and, rarely, pieces of mother-of-pearl. The tesserae are in a foundation of lime plaster. Vitruvius and Pliny describe the preparation of walls for plastering, the procedures for making lime and lime plasters and their application to the walls in several coats up to six or seven layers of plaster in slightly different compositions and colours for a support of mural decorations (1). However, the number of plaster layers generally found as a foundation for wall mosaics rarely exceeds three in number although one example does exist at Sardis where five distinct coats may be observed. This is a half dome in one of the niches surrounding the large pool of the Sardis Gymnasium-Bath complex and probably dating from the 2nd century A.D. (Fig. 1). The mosaic cubes from the half dome have all fallen although impressions of tesserae remain in the top thin layer of white plaster and the lower four levels are in varying shades of pink and grey.

Wall mosaic setting beds are prepared by mixing lime putty, inert materials such as sand, pulverized stones, straw and other organic materials and water. The lime is prepared by heating limestone and/or marble (calcium carbonate) in a kiln to a temperature above 900 °C at which temperature carbon dioxide is expelled and calcite is converted into calcium oxide. The oxide is saturated with water with the evolution of a great amount of heat and calcium hydroxide or lime putty is produced. This slaking of lime should extend over long periods in a lime pit to ensure complete conversion from the oxide to the hydroxide. When the lime putty is mixed with inert fillers and water and the lime plaster is exposed to the air, crystals of calcite are formed as the hydroxide combines with carbon dioxide from ambient air. These calcite crystals

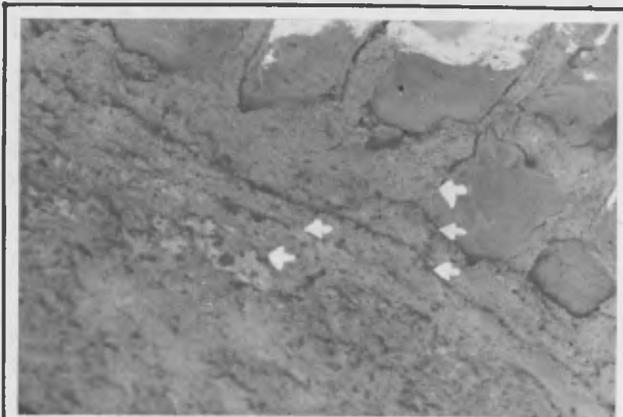


Fig. 1 - Half dome vault, detail, of Gymnasium-Bath Complex, Sardis, Turkey, 2nd c. A.D. The plaster is applied in five layers in a manner described by Vitruvius. Although no mosaics are *in situ* the depressions made by cubes in the setting bed are visible

bind the inert materials together into a hard and durable surface and lock the tesserae in place.

The various layers of plaster, usually three, generally vary somewhat in colour and composition. That which is applied directly to the masonry to cover irregularities in the stone and/or brick wall often consists of one part lime putty to about three parts inert materials of usually a mixture of sand and brick dust and sometimes with the volcanic ash material *pozzolana*. The powdered brick improves the durability of the plaster and *pozzolana* makes the plaster of a hardness like Portland cement. One may also find bits of charcoal, sea shells, mica and other extraneous fillers in this first plaster layer. Since the masonry may be quite irregular, this preliminary plaster coating may vary in thickness from one or two centimetres up to ten or more and is generally pink or light grey in colour. The surface is often textured with the trowel to provide a mechanical bond for the next coat (Fig. 2). The second plaster layer is often rich in organic material such as straw, hair or other fibrous substances along with sand and pulverized old plaster and sometimes old mosaic cubes that are found in reused fallen plaster employed as an inert filler. This lime, straw, inert inorganic mixture may be quite thick and is usually of about the same thickness over the entire wall, perhaps two to five centimetres. This intermediate layer may also be given a slightly textured surface to ensure good adhesion of the final setting bed plaster. Although it has been reported that compositional sketches have been made on the *arriccio*, the author has never observed such equivalents of the *sinopia* of some periods of fresco painting (Fig. 2).



Fig. 3 - Mosaic of St. Paul in the Kariye Djami, Istanbul and part of the Deisis. Areas of painted plaster are visible where cubes have fallen out



Fig. 4 - Detail Fig. 3 showing clearly that a true fresco was painted on wet plaster to guide the mosaic setter



Fig. 2 - Mosaic in a south-west room of St. Sophia. The first layer of plaster with troweled surface is visible on the right

The top layer or *intonaco* is usually a fine white plaster composed of a mixture of lime putty, marble dust, and perhaps some fine sand or sifted reused old plaster. This is applied in a *giornato* or an area that can be set with tesserae in one day, although unlike the plasters in *buon fresco* painting it is very difficult to observe where one day's plaster ends and the following day's plaster begins. The *intonaco* plaster is painted in true fresco very soon after its application, often with complete modeling of details so that the mosaic setter has merely to match coloured cubes to painted plaster as he sets the cubes one by one using appropriate tools to break and trim individual cubes where necessary to follow the brushwork of the painter. In a number of mosaics in Byzantine monuments in Istanbul the cubes have been lost but the painted setting bed remains, sometimes with tiny bits of the bottoms of the cubes still *in situ* (Figs. 3 and 4). And in the Fethiye Djami there are large sections of painted *intonaco* which have been set with only a few cubes as in the feet and hands of the Virgin and St. John the Baptist in the *bema* of the apse of the mortuary chapel. Here painted areas are outlined with mosaic cubes and perhaps the plaster was hardening and intermediary areas were not set.

There may not have been quality control and the mosaic setters knew that the lack of total surface coverage with cubes would not be detected by observers at some distance from these dark vaulted areas.

In St. Sophia, in the mosaic of Leo VI before Christ Enthroned, the mosaicist takes advantage of the location high above the observer. Here cubes are widely spaced, particularly in the gold background, where cubes are spaced far enough apart that additional rows could have been inserted. These gold cubes are tilted about 30° from the vertical so that from the floor of the inner narthex the gold background appears to be completely covered (Fig. 5).

Wall mosaics have been called paintings encrusted with bits of glass and stone to suggest compositions in precious gems and made to last forever. Many are surprisingly well preserved after centuries of neglect but like other works of mural decoration they require conservation attention from time to time. Without doubt the greatest cause of their deterioration, other than wanton destruction, is water seepage up from the ground, from leaking roofs and walls, and water condensation. Water weakens and dissolves parts of the plaster support and acts as a carrier of destructive chemicals and salts.



Fig. 5 - Detail of the Leo VI mosaic in St. Sophia showing wide spacing of cubes in the gold background. These cubes were set at an angle to the vertical to give an illusion of a solid

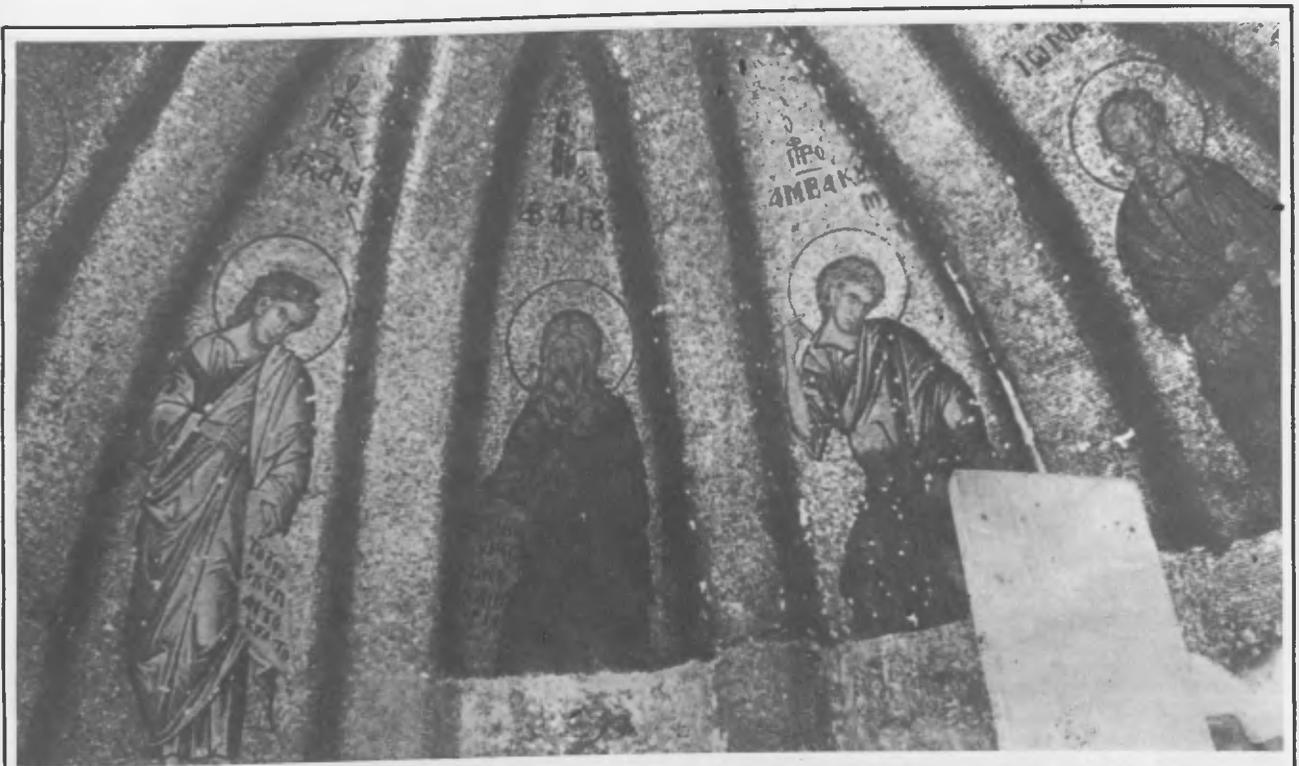


Fig. 6 - Dome of the Fethiye Djami in Istanbul during conservation. Covering plaster has been removed from the lower part of the mosaic and cramps have been used to reattach the mosaic to the masonry

Oxides of sulphur combine with water to produce sulfurous and sulfuric acids which dissolve calcite and convert it into gypsum. Gypsum occupies about twice the volume as calcite and in the process mosaic cubes as well as whole areas of plaster may be lost. Various water soluble salts transported through the setting bed will form crystals as the water evaporates at the surface just below the cubes with resulting movement and loss of cubes as salt crystals are formed.

Problems of conservation of wall mosaics include: 1. Conservation and repair of the walls, vaultings and roofs. 2. Provision for proper drainage and water barriers to prevent water rising in walls by capillary action. 3. Provision for adequate air circulation to prevent condensation and maintain moisture equilibrium within the room housing the mosaic. 4. Investigation and treatment of cleavage or possible separation of the plaster layers from the masonry. 5. Treatment of cleavage between the layers of plaster. 6. Treatment of decay, desiccation and deterioration of setting plaster. 7. Reattachment of individual loose cubes. 8. Cleaning of cubes and interstices. 9. Consolidation of edges of loss. 10. Filling or other treatment of lacunae, and 12. Final presentation.

Foundations of structures, walls and roofs must first be repaired before any treatment is applied to the wall mosaic or its setting bed. This may involve replacement or repair of lead, tiles or other roofing or even replacement or

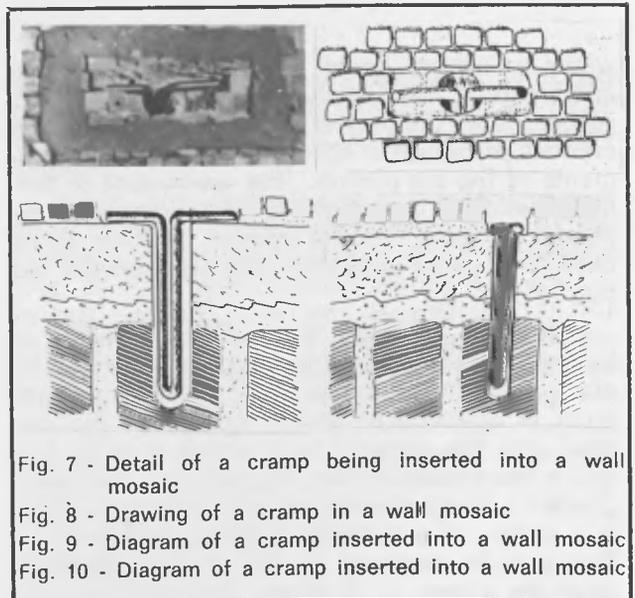


Fig. 7 - Detail of a cramp being inserted into a wall mosaic

Fig. 8 - Drawing of a cramp in a wall mosaic

Fig. 9 - Diagram of a cramp inserted into a wall mosaic

Fig. 10 - Diagram of a cramp inserted into a wall mosaic

repair of architectural elements. Drainage systems may be in need of repair or installation and windows may need to be installed or repaired to establish good ventilation. Cross ventilation and sufficient movement of air in a building with wall mosaics is most important in preventing deterioration from moisture problems.

Deteriorated plaster supports may need to be consolidated before any cleaning can be considered. Desiccated and crumbly plasters can often be strengthened by application of lime

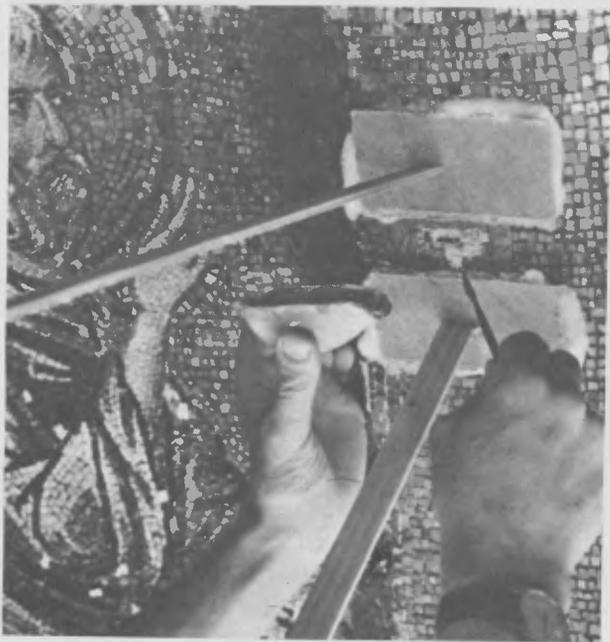


Fig. 11 - Plastering in the cramp in a wall mosaic. Braces are applying light pressure to the mosaic in an area where thinned lime plaster has been injected



Fig. 12 - Replacing the cubes that had been removed for installation of the cramp

water or almost liquid lime putty by injection and brushing. Such application of thin lime putty reconstitutes the plaster setting by creating new crystals of calcite to reinforce the weakened elements of the old plaster. This application of thin lime injections may need to be accompanied by gentle pressure on the mosaic surface using pads and braces until the putty has partially set (Fig. 11).

Cleavage between the wall and plaster or between layers of plaster may be remedied by plaster injections but a more secure reattachment is obtained by installing cramps that extend into the masonry with wings that lie just below the mosaic cubes. In order to install such cramps a few tesserae are removed and placed in a matrix of a material such as plasticene so they can be replaced in the original positions after the cramp is in place. The small area of plaster exposed by removal of about six or eight cubes is then drilled with a hand drill and bit to a depth of about five centimetres into the masonry wall. A cramp is then manufactured from heavy copper or stainless steel or monel metal about three or four mm thick; it is made to fit the drilled opening extending into the masonry and with wings overlapping the *arriccio* plaster (Figs. 7 - 10).

The drilled hole is filled with plaster and the cramp is inserted into the wet plaster until the wings rest on the *arriccio* plaster (Fig. 11). After

the plaster around the cramp has set the cubes that were removed to prepare the drill hole are reset in new plaster (Fig. 12).

If areas of plaster are loose from the masonry or if there are areas of interlayer cleavage between layers of plaster, injections of thinned lime putty of the consistency of cream may be made with a syringe through the drilled hole before insertion of the cramp.

The mosaic surface is braced with mild pressure to assure good contact between the cleavage areas while the lime putty is setting (Fig. 11). The combination of cramps and plaster injections has been used successfully by the conservators of the Byzantine Institute of America on several wall mosaics in Byzantine monuments in Istanbul, Cyprus and Mount Sinai.

The installation of cramps goes hand in hand with cleaning and consolidation of surfaces. Frequently mosaic surfaces have been covered in part or totally by applications of whitewash or paint and/or plaster. All representational mosaics in Byzantine monuments in Istanbul were whitewashed or painted or plastered over at various periods when the buildings were in use as mosques. The layers of plaster covering the tesserae were scraped away to expose an area for cramp installation where necessary. Each cube was cleaned individually as well as the interstices between cubes using dental tools, orange wood sticks, and tooth brushes with a little



Fig. 13 - Portrait of the Byzantine Emperor Alexander in St. Sophia. The background is a mixture of gold and silver tesserae. *Giornati* joins can be seen along the left side of the figure

water. Large amounts of water must be avoided as it softens the setting bed. Each loose cube was removed and reset with fresh plaster. Where cubes were missing the exposed painted setting bed would be carefully cleaned by mechanical procedures and often the cleaned painted surface would complete the composition (Fig. 3-4). Where small areas of setting bed were lost within a mosaic surface, the losses were filled with lime plaster mixed with marble dust or sifted old plaster - one part lime to two or three parts inert. The Emperor Alexander portrait in St. Sophia (Fig. 13) is an example of a mosaic that was painted over and so cleaned and consolidated. This mosaic is of particular interest in that *giornati* can be observed to some extent in the setting plaster - the head and upper bust were set in one day, inscriptions in one day, and the upper torso in another day. One can observe where one day of plaster joins that of another. This mosaic is also noteworthy because of the large number of silver cubes in the background - no doubt to reflect light from the dimly lit area where this figure is located - high up on the north-west pier supporting the great dome of St. Sophia.

The consolidation of the Deisis panel of the south gallery of St. Sophia is well described and illustrated in a publication of the Byzantine Institute (2). The plaster covering applied by the Fosatis in the mid-19th century was removed,

cramps installed and edges reattached with new plaster. Holes were filled with plaster and toned with neutral grey tones. No new cubes were inserted.

In the large Deisis panel of the Kariye Djami large areas of mosaic cubes were missing and treatment of lacunae posed a difficult problem (Fig. 14-16). Much painted setting bed was revealed including some new inscriptions (3). The painted setting bed suggested procedure for filling large losses. These areas were plastered with lime plaster and smoothed to a flat surface (Fig. 14). These flat areas were then textured with a small chisel to resemble areas of original setting bed and toned with water-colour (Fig. 15). Where larger losses existed, water-colour tinting connected existing patches of coloured setting bed to complete a large portion of the design (Fig. 16). Nothing new was invented. No new cubes were inserted and areas of complete loss were tinted in a flat tone with no attempt at reconstruction of missing parts.

A fragment of a 4th c. A.D. wall mosaic from the Great Synagogue of Sardis is illustrated in Fig. 17. The plaster is in three layers - a pink plaster over the brick wall about one to one and one-half cm. thick. The intermediate plaster is about three cm. thick and consists of a mixture of lime, sand and straw. The setting bed is about one and one-half cm. thick and is composed of lime and marble dust. The cubes of glass and



Fig. 14 - Detail of the Deisis mosaic of the Kariye Djami, Istanbul, during cleaning and consolidation. A new inscription has been found in the painted plaster where cubes have fallen. Holes have been filled with lime plaster

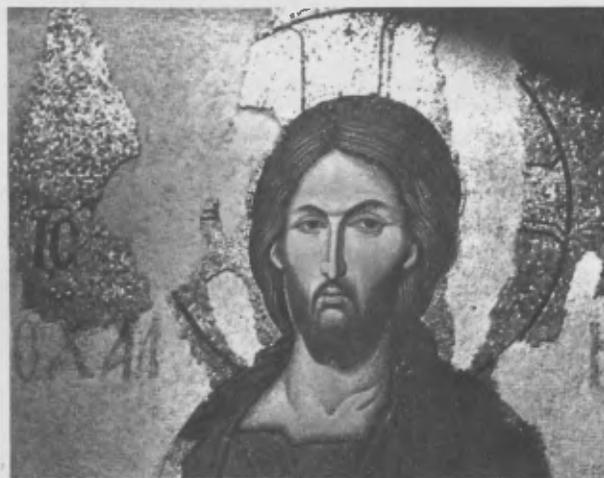


Fig. 15 - Head of Christ of the Deisis after treatment



Fig. 16 - The Deisis of the Kariye Djami showing method for treating lacunae

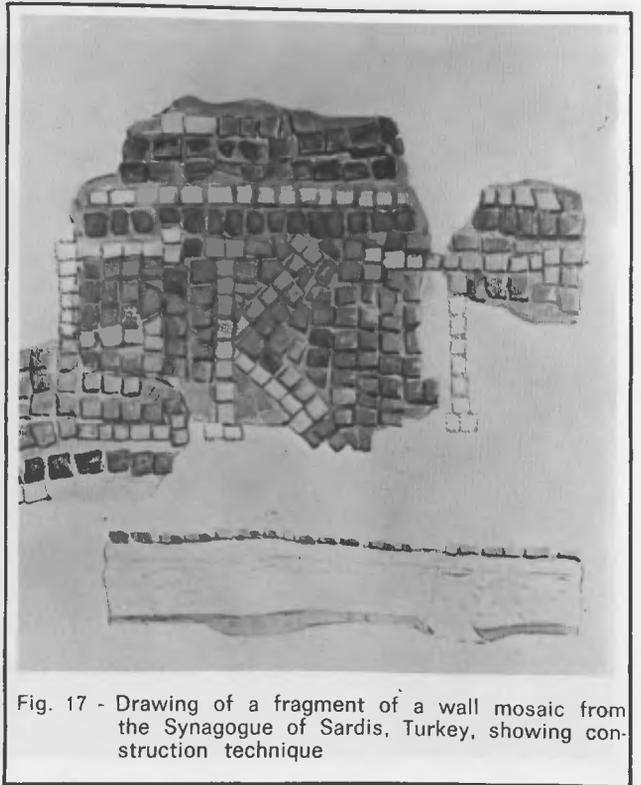


Fig. 17 - Drawing of a fragment of a wall mosaic from the Synagogue of Sardis, Turkey, showing construction technique

natural stone are set in the painted surface somewhat spaced to reveal areas of the painted plaster. The fragment is part of a dedicatory inscription from the forecourt of the Synagogue.

While at Sardis the author prepared some small demonstration "wall" mosaics on bricks to illustrate the techniques used in the Synagogue (Fig. 18). The setting of the cubes in the plaster of one brick took the author one hour. At that rate it is estimated that it would take 40 hours to set one square metre. Perhaps a skilled mosaic worker could set between one

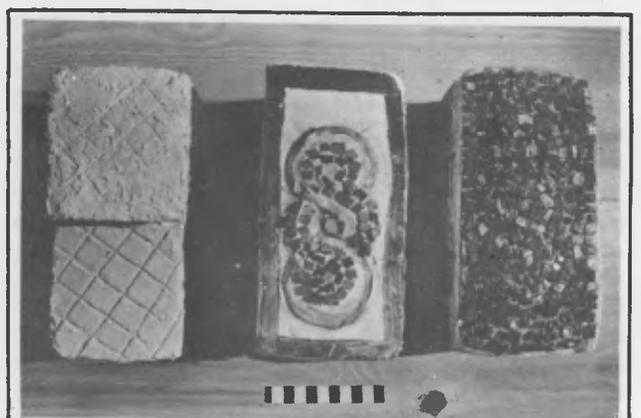


Fig. 18 - Samples prepared as a demonstration of wall mosaic technique. The brick on the left is covered with the first two layers of plaster. The center brick has been painted in true fresco and a few cubes have been set. The brick on the right is completed and required one hour to set the cubes in the painted *intonaco*.

half to one square metre in a day - not counting time for preparation of the wall and setting plaster.

The above is a brief description of treatment of wall mosaics as practised by the conservators of the Byzantine Institute of America. Obviously many details of procedure and technique are omitted in such a cursory report. No written report can adequately summarize pro-

cedures in order that they can be followed by another without supervision.

Notes

- 1 Vitruvius, *Ten Books on Architecture*, New York, Dover, 1960, VII, p. 204 ff.
- 2 T. Whittemore, *The Mosaics of Haghia Sophia in Istanbul, Fourth Preliminary Report*, Oxford, University Press, 1952.
- 3 P. Underwood, *The Kariye Djami*, v. 1 & 2, Bollingen Series LXX, New York, Pantheon, 1966.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions. We have, however, tried to record the essential points, thus showing the general direction of the discussion which followed the lecture of Mr. Majewski.

Mme. Andreescu: Am I right, I seem to notice a certain looseness in the texture? Some of the spaces between the tesseræ are white.

Mr. Majewski: It could be that the treatment has not been finished.

Mme. Andreescu: Is it the setting bed we see between the tesseræ?

Mr. Majewski: That's possible. Probably they haven't finished working on it.

Mme. Andreescu: How do you put the crampons in?

Mr. Majewski: They're put in while working on the surface.

Mme. Andreescu: Did you and Ernest Hawkins yourselves choose this method of reconstructing the mosaic foundations? Up to what point have you remained faithful to the surviving traces of the original work - or, in other words, some of these lines we see, have they been drawn by you?

Mr. Majewski: If you're speaking of the Christ of the Deesis, we have there specific points between which we have drawn some lines.

Sig. Torraca: The crampons, are they set in mortar?

Mr. Majewski: Yes, except in the case of small surfaces where plaster of Paris was used.

THE RESTORATION OF MOSAICS IN GERMANY

by Rolf Wihr

Translated from the French
by Patricia Bonicatti

The first German mosaics were discovered in the second half of the 19th century at Trier. At that time lifting procedures were not yet developed; trained restorers did not exist, but rather manual workers were employed in various tasks in the museums then being founded. It might have been a guard, for example, who glued together scattered bits of ceramics, or who made the excavations. Detaching and restoring mosaics was also considered a part of his job. Considering the lack of technical means and know-how at their disposal, these people succeeded rather well. In breaking up the mosaics, the motifs were preserved but it was impossible to save the surrounding decoration. These broke by themselves when the motifs were chiselled out. Wooden braces were put around the fragments, and thanks to these, it was possible to remove the sections intact with the mortar, which was 12-20 cm. thick. The fragments were taken in this form to the museum for display. Considering the weight of the combined mosaic and mortar, it was necessary to form very small fragments and thus the loss of original work was immense.

At the turn of the century, the technique of gluing mosaics was begun in Germany, having originated in Italy. Bone-base glue was used, but it was still necessary to work with small fragments because ground humidity prevented the glue from adhering satisfactorily, and scientific means to dry large surfaces were not available. (This problem was less acute in Italy due to the dry summers). The mosaics were dried with alcohol or an acetylene torch; but as the glue was very sensitive to infiltrations of water, one could not glue and remove smaller or larger parts of a mosaic without the loss of one or two rows of tesserae at a time to delineate these fragments. Using a long, thin chisel the mortar was split between two layers which permitted the lifting of the mosaic; this method proved to be satisfactory as long as the mosaics were relatively small. If they were large, the difficulties persisted as it was nearly impossible to insert the chisel under the surface of the mosaic,

and still stay between the two layers. In effect, small irregularities in the mosaic or the little pebbles which were lodged between the two layers of mortar caused the chisel to slip downwards or, even worse, upwards. There was therefore a great risk of piercing the mosaic. The excavated fragments were still extremely heavy and it was necessary to remove the mortar completely in the workshop with hammer and chisel. Sometimes, due to the hardness of the mortar, there was also a danger of splitting the cubes.

This was the technique I encountered when I began working as a young restorer. After a while, I was able to replace the bone-base glue with polyvinyl acetate diluted in ethylacetate (known under the brand name Mowilith 35/73 - Farbwerke Hoechst, Frankfurt-Hoechst, W. Germany). This glue was not soluble in water, but it was still necessary that the surfaces be absolutely dry in order to adhere sufficiently and to avoid water infiltrations which might separate the glue from the mosaic before detachment. In order to avoid this risk and to permit the removal of larger sections, we began to dry large surfaces using 2,000 watt infra-red lamps. Even though the problems of drying were thus partly resolved, those of the hard mortar, of the uneven surface of the mosaic, and of the small pebbles between the two layers of mortar remained just as acute. Also the detached fragments were still very heavy and it was very often impossible to avoid splitting the original material without cutting it with an electric saw, following the "Bassier method". At that time, we were unable to saw the mortar as we had neither the technical means to carry out the work nor any means of preventing accidents. These problems led us to seek a new method.

While on a trip to Italy in 1951, I saw frescoes at the Central Restoration Institute, then under the direction of Professor Vermehren, which had been detached from a wall by being rolled off. Several years later, Stefano Locati used the same method on the mosaic of Dionysos at Cologne, after we had met at Trier. However, it was still impossible for me to remove a mosaic with this

method at Trier, because of the traditional nature of the work there. So I was obliged to wait for another occasion. During this period, I was able to make progress in the technique of laying mosaics. We had in our museum several hundred square metres of mosaics still glued to cotton cloth, or others which were already set in plaster or cement, and kept in storage. It was necessary to arrange them so that each fragment might be visible without wasting time or labour. It was also necessary to assemble the fragments of the central motif. I resolved this problem by creating a fine bed of Araldite D, adding 200 % of sand and 15 % of Hardener HY 956 to it and reinforcing it with fibreglass. Next the beddings were hung on a rail: this made it easy to handle the fragments by sliding them along the rail, thus allowing assemblage of the principle design. This took me years to accomplish (Fig. 1).



Fig. 1 - Storage area with hanging mosaics (bedding made of Araldite D, hardener HY 956 and 200 % sand, reinforced with fibreglass)

At last I had the opportunity for which I had waited ten years. A hundred years earlier, excavations had been made in the Trier region, where a Roman villa had been discovered. Five rooms were paved with mosaics. As they could not be detached at the time, it was decided to leave them *in situ*, protecting them from the elements by small sheds. A hundred years later (World War II also doing its share of damage), the mosaics had clearly deteriorated. Some of them had a hollow ring; they bulged and threatened to crumble at the first touch. Other pieces had already disappeared and the damage increased daily. It was urgent to solve the problem by detachment of the mosaics. The original Roman

mortar had to be removed and replaced by modern mortar. Naturally we had to detach them in the traditional way, which we did for the first four. It was obvious that much of the original material would be lost, and we also knew that after the detachment the real work would begin: transporting them into the workshop, removing the mortar, laying the cleaned mosaics in plaster as we had always done, ungluing the cotton cloth, filling in the holes, assembling the fragments and covering up the chisel marks, re-separating the fragments, transporting them and replacing them in their original locations, as well as repairing the damage done to them during restoration.

I was given permission to proceed according to my own method with just one of these mosaics (the smallest one, which measured 3 x 4 m). As all the mosaics had been kept sheltered, they were not particularly damp and so I took the risk of gluing mine in one piece. It was to be replaced in its original location. These two factors were important for the success of my method.

We built three wooden discs, each 90 cm in diameter and 2 cm thick. In the center of each disc we made a hole. We spaced the three discs so that there was 1.5 m between them. Then we formed a drum by juxtaposing slats of wood 5 cm wide and 2 cm thick and attaching them to the discs. This cylinder was light in weight and could be assembled and dismantled easily. The mosaic was glued, in one piece, with Mowilith 35/73 to cotton cloth. After it dried we installed the rolling wooden drum on the 3 m side of the mosaic, which we then began to split directly between the cubes and the mortar. The separation proved no problem even where the mortar was very hard (Fig. 2). Rather than removing it, we left the modern concrete from the previous



Fig. 2 - Removal of a mosaic with a cylinder

century's restoration which was 2 cm thick, on the rolled mosaic. After two hours and two turns of the drum, the 12 m² pavement was completely rolled up. We placed a steel rod in the hole through the entire cylinder, and on each end we added a new wooden disc a little larger than the original ones. We installed screws in order to fasten the two discs on each end. We wrapped very strong paper around the mosaic on the cylinder and secured it with ropes.

After that we were able to roll it away.

Almost a year went by before we applied a layer of reinforced concrete and an insulation against soil dampness. During this time we restored the four other mosaics in the traditional way. Four and sometimes six men were busy all year long doing this work. In the meantime, I was busy with other projects. At the end of the year I wanted to replace the mosaic in the same way in which it had been rolled up. We placed the cylinder in the same position, then we added on the top of the reinforced concrete another insulating layer to the cement mortar, 3 cm thick. To make the mortar adhere and to insure its flexibility, I ordered the addition of 10 % dispersion of Mowilith. Thanks to the two larger terminal discs, the cylinder did not touch the fresh mortar. We worked on a small bridge spanning the mosaic which allowed us to level and attach the mosaic to the fresh mortar easily. Two hours later (including the preparator work) the job was finished. We rolled the cylinder aside and let the mortar dry. Three days later, we detached the cloth which had been glued with Mowilith. This was not difficult as, in the meantime, a lot of dampness had risen from the soil and had unglued the cloth from the mosaic.

After replacement on the ground, our mosaic showed some imperfection: at the point where we had begun to unroll the mosaic it sank about one centimetre. In effect, its weight had caused the fresh mortar to slip and there was not enough mortar there to keep it level. Furthermore, it did not adhere as well as I had hoped and I realized that the man who prepared the mortar had ignored my orders and had not added the 10 % dispersion (to improve the adhesion of the mortar). He had added a product to liquify the mortar, and the result was exactly the opposite to that which I had intended. However, the technique which I used may be considered successful in spite of these small drawbacks.

At that time, the cost of traditional restoration per square metre of mosaic came to exactly 1,200 Deutschmarks. The restoration cost per square metre using the new method was about 110 Deutschmarks: less than one-tenth as expensive.

Perhaps we could improve the technique of rolling and unrolling the mosaics, using a mixture of Araldite and sand as a mortar bedding. In this case, it would be necessary to unglue the cloth

with solvent. The bedding mortar would be slightly more expensive, but this would be a minor disadvantage compared to the economy of this method as against the traditional one.

Several weeks later another mosaic, 60 m², was discovered at Bad-Kreuznach. It was summertime, but in Germany it rains more during that season than in Italy so we erected a tent to protect the mosaic. Initially we began to dry the first part with infra-red lamps; then we glued and removed it according to the traditional method. The mortar of the mosaic was extremely hard and so we made very slow progress. We could only dig up very small parts at a time as dampness rose rapidly from the ground. Once again, we lost a great deal of the original material due to the hardness of the mortar. This mosaic was unlike those usually found in Germany (which are generally composed of geometric motifs) and more like those found in North Africa with elements forming a scene, so it had to be broken up into large sections. At the same time, it was imperative that the mosaic be able to pass through the museum doors and therefore we had to divide it into sections of 2 x 2 m or 2 x 3 m and roll them up.

A detachment plan was established: we decided to divide the mosaic into sections and dry them with our large infra-red lamps. As the mosaic was very damp, we could only dry, glue and roll up 4.5 m² each day on our cylinder. At first, we separated the mosaic tesserae from their support by hand and later continued the work with a small pneumatic hammer, which saved a great deal of time and effort (Fig. 3).



Fig. 3 - Separation of the tesserae with a small pneumatic hammer

Once detached, the sections were progressively rolled onto the drum. Thanks to this we could always see exactly where to place the pneumatic hammer to separate the tesserae from the mortar. The separation of the glued fragments

from the mosaic still remaining in place was no problem. We proceeded as follows: on the edges of adjacent sections which were not yet being removed, we glued another strip of cloth 5 cm wide from top to bottom at the level of the demarcation line (Fig. 4). Then, over the cloth



Fig. 4 - A glued piece of mosaic, ready to be separated. At the end, a glued strip of cotton at the edges of adjacent sections

strips, we placed straight pieces of wood or metal which served two purposes: they acted as a support for rolling the cylinder on top of the mosaic, and as a protection against splitting the fragments along the demarcation line. Using this method, we could work without loss of original material (Fig. 5). The sections which

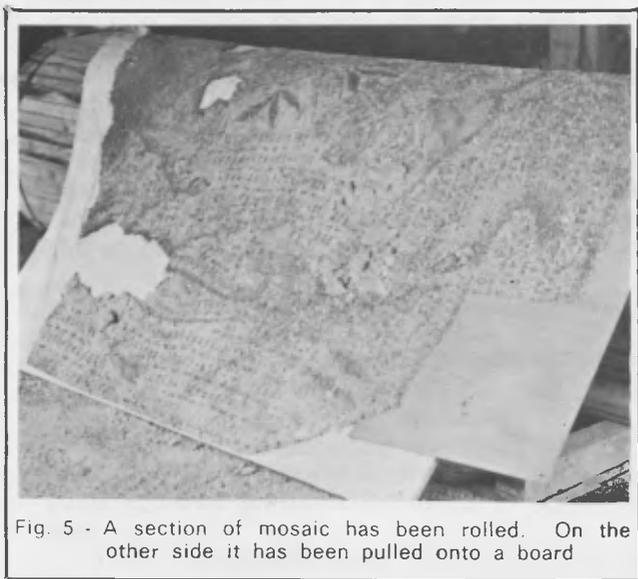


Fig. 5 - A section of mosaic has been rolled. On the other side it has been pulled onto a board

we separated from the rest of the mosaic were only rolled a half turn of the cylinder, and on the other side we gently pulled the section to spread it out flat. Having positioned the mosaic



Fig. 6 - Cleaning of the tesserae with an ultrasonic hammer



Fig. 7 - The reverse side of a mosaic, cleaned by an ultrasonic chisel. The design on its other side is clearly visible

face down and level, we were still able to distinguish the different scenes from the back and proceeded to cut up the mosaic, piece by piece,



Fig. 8 - Honeycomb support being placed on the reverse side of a section of mosaic

with a knife, without losing any of the original material.

We loaded the sections onto a truck and transported them to our workshops where they were remounted. Since then, they have been waiting to be restored. Before leaving Trier, I was able to direct the continuation of the restoration: cleaning the back of the mosaic wherever it proved necessary with an ultrasonic chisel of 22 or 44 KHz (Ultrachall GmGh. D6148 Heppenheim) as is done in restoring frescoes (Fig. 6-7) and laying the pieces in Araldite on a honeycomb structure of aluminium (Aeroweb - CIGA-Geigy, Basel, Switzerland), following the method devised by Claude Bassier (Fig. 8).

I foresee great possibilities in improving the technique of detaching and restoring ancient mosaics, in their removal, rolling and unrolling without loss of original material and in cutting their reverse side, in their cleaning with ultrasonic chisels, and in their relaying in Araldite on honeycomb aluminium structures.

I hope that I have been able to give you some useful suggestions, and I thank you for your attention.

The discussion which followed this lecture will be found on page 81.

SOME PROBLEMS IN THE CONSERVATION OF MOSAICS

by Claude Bassier

Translated from the French
by Alan Bonicatti

First of all, I would like to thank Dr. Feilden, ICCROM, and all its members for their cordial hospitality. Most especially I would like to thank my friend Gaël de Guichen for his initiative in organizing this symposium. Thanks to him, we are gathered today to study the problems posed by the conservation of mosaics.

The area which was formerly the ancient Roman world is rich in mosaic pavements, but poor in conservation technicians. For this reason, at the instigation of M. Chabert (then Director of the French Antiquities Service), we set up a private conservation studio to work exclusively for the state. For the past 12 years our main activity has consisted in saving, conserving and treating mosaics and mural paintings.

Where conservation is concerned, one must automatically deal with deterioration and destruction. Every moment of their lives, from creation to final destruction, mosaic pavements are subject to an evolutionary process of deterioration. One can speak of "conservation" only from this perspective.

The conservation of mosaics is basically conditioned by socio-economic and socio-cultural factors. In France, these factors effect processes which are particularly detrimental to mosaic conservation:

1. More than 90 % of the mosaics brought to light are destroyed.

2. Very few mosaics are conserved *in situ*; of those so conserved, all are in a state of advanced and irreversible deterioration.

3. Among the mosaics removed and transferred over the past century, more than 90% have suffered grave deterioration or have been lost.

Thus, statistically speaking, the field of conservation as a technique touches only a tiny percentage of the mosaics discovered.

The administrations in charge must be informed of the real problems and strive to unify their efforts through extensive study of the factors which are responsible for this state of af-

fairs. Any effective action must lead to changes in present legislation, administrative structures, and intervention processes.

Technical conservation interventions, which are the only ones with which we are concerned here, must always be seen in this context or they will entirely lose their significance.

Conservation is not the application of a collection of recipes of procedures. It is founded on the experience provided by our predecessors and colleagues, on systematic criticism of our own work, on historical research and on the natural sciences.

Every conservation operation must be based upon the collection and integration of three kinds of information:

1. Complete knowledge of the nature and structure of mosaics and each of their constituent parts.

2. Thorough knowledge of the cause of deterioration, evolutionary processes, or threats of destruction.

3. The future placement and role of the mosaic after eventual conservation and restoration work. Testing of techniques and interventions.

A judgement based on the mosaic's future is the principal factor in directing the processes of conservation or restoration. This choice is effected by socio-economic and socio-cultural factors; these alone should be the topic of a meeting.

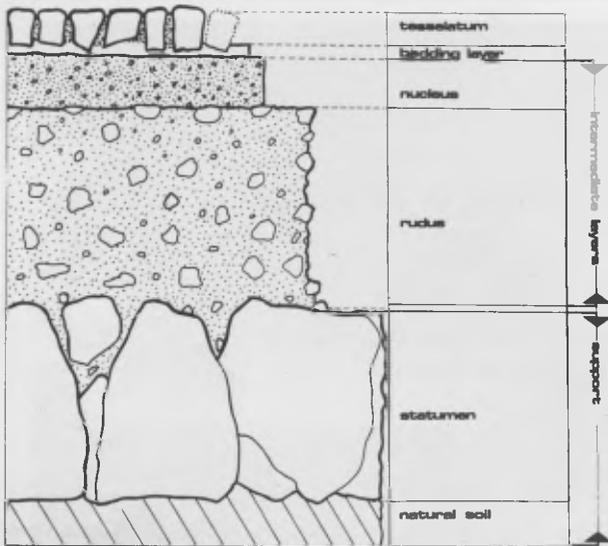
Let us take the three points above:

1. Knowledge of structure

From the ground up, a mosaic pavement is composed of three major strata: a support, intermediate layers, and the tesserae.

- The actual support includes: the ground (natural soil), the *statumen*, or support.
- The intermediate layers consist of: the *rudus*, or foundation, the *nucleus*, or base.

THEORETICAL STRUCTURE OF A MOSAIC



This assemblage assures the spatial cohesion of the tessellated layer under mechanical stress. Its essential role is one of mechanical resistance; this is obtained by the superimposition of the layers mentioned above. These layers constitute the structure, the strength, and also the weakness of the pavement.

— The tesserae are small square, usually cubic blocks which measure less than 25 mm per side. They can be of marble, ceramic or glass paste.

— The tesserae are small, square, usually obtained:

- within the pattern layer by joining them to each other;
- between the tessellated layer and its support through the setting bed.

2. Knowledge of the causes of deterioration

2.1. Mosaics *in situ*.

Aside from the method and means which one has at one's disposal, analysis of mosaics does not present any particular problem. On the contrary, it is necessary to stress the most frequent and most dangerous causes of deterioration and destruction. We have very few wall mosaics in France - all classified as historic monuments - but the earth holds considerable numbers of mosaic pavements: only these last will be considered here.

Lacking a national mosaic register and appropriate juridical and technical measures, more than 90 % of the mosaics discovered in France are destroyed by agricultural operations, construction projects, and public works, often before there has been any opportunity to record them. Destruction has occurred at Nimes, Poitiers, Perigueux... (Figs. 1 to 4). The 10% of mosaics that escape industrial vandalism suffer further dam-

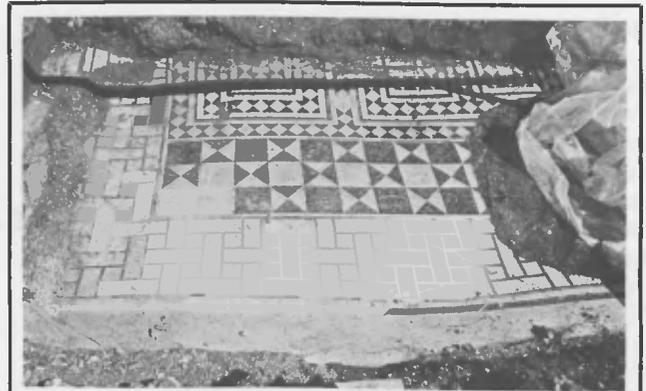


Fig. 1 - Poitiers, construction of a parking lot next to the cathedral. Sunday, 2:00 p.m.



Fig. 2 - Poitiers, Monday, 8:00 a.m. A bulldozer begins taking away pieces of the mosaic



Fig. 3 - Poitiers. The mosaic is completely destroyed



Fig. 4 - Perigueux, the destruction of the remains of an antique polychrome mosaic, 1977

age at the hands of archaeologists and administrators. The former are often unfamiliar with simple precautions for impeding deterioration; the latter react too slowly - if they react at all.

Mosaics are ruined by the destruction of the support, by the deterioration of the tesserae and the joints between them, by deterioration of the material in which they are set or of the bond between the tessellated layer and its support, and by the destruction of the actual tessera layer. The latter can occur very rapidly if the pavement border or lacunae are not kept in good repair.

The origins of these disorders are: fire, humidity, water-borne chemicals in the atmosphere or the ground, plants, animals, men, and machines. These agents provoke different stresses which act both separately and together.

2.1.1. Mechanical stress: compression, shock, etc. Mechanical stress perpendicular to the surface causes horizontal compression of the upper part of the support and traction in the lower part. These horizontal stresses in opposite directions tend to make the layers slide across each other; they are likely to crack the support in its weakest point - i.e. the stratification beds in order of fragility.

When vertical stress is applied to a pavement where the support has both strong and weak resistance areas, the support buckles cracks, breaks, or sinks. Subterranean water produces the same phenomenon.

Lateral stress has the same effect, but in an even more pronounced manner.

2.1.2. Thermal stress: in the presence of a water vector, the thermal stress of frost provokes swelling of porous materials. Tangential stresses include splitting, flaking and splintering. Heat and fire provoke dilation and cleavage

in the heart of stratification layers, and the destruction of the tessellated layer or of its constituent materials.

2.1.3. Biological stress: Plants and their roots, micro-organisms, burrowing animals - of which man is the most dangerous species - all participate in the deterioration and destruction of pavements and accelerate the degenerative process; the tessellated layer suffers the most from this type of deterioration (Figs. 5 to 8).



Fig. 5 - A typical site in which an unprotected mosaic is slowly disappearing

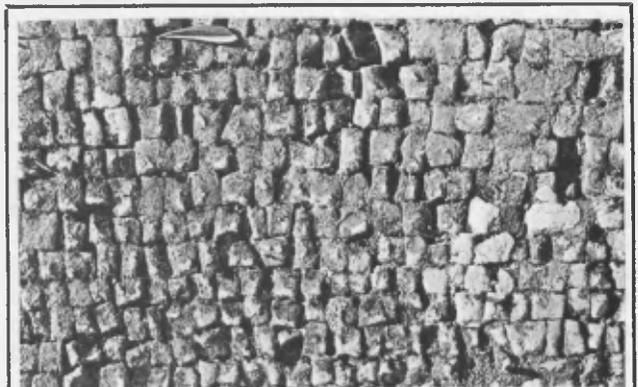


Fig. 6 - Tivoli, an unprotected mosaic *in situ*, damaged by weather, micro-organisms and vegetation



Fig. 7 - Piazza Armerina, an unprotected mosaic *in situ* undergoing the same changes



Fig. 8 - Loupian (Hérault), an unprotected mosaic *in situ* undergoing similar changes. Note a localized destructive process

To give man his due, one notes that he can become aware of the negative aspects of his activities and can also participate in conservation and restoration.

2.1.4. Chemical stress: Water vectors carry soluble salts and organic acids. Through the products of their chemical or biological transformation, these agents directly attack the pavement's constituent elements, particularly at the joints and the stratification layers. Chemical stress contributes to deterioration of materials and the destruction of pavements.

2.2. Mosaics transferred to museums

Experience has shown that the circumstances favourable to the conservation of a mosaic in its original location can rarely be achieved. Consequently, the best method of conservation consists of separating the mosaic from its original support and transferring it onto a new one. With this method, the materials and structure of the tessellated layer, which constitutes the main interest of a mosaic, are conserved.

Even when a mosaic is lucky enough to survive for treatment, it still must receive the attention of a sufficiently qualified technician. My friend Rolf Wihr has shown us a removal operation done with a large roller. This difficult operation was a complete success because Rolf is a careful and highly qualified technician. In contrast, this same technique employed by an insufficiently experienced restorer led to various catastrophes in Saint-Romain-en-Gal.

Even when a mosaic is not destroyed by mechanical agents, careless excavators, administrative delays, or inexperienced technicians, it is certainly not yet out of danger.

For the past twelve years, numerous French museums have sent us their mosaics, which were "restored" in the period between 1814 and now. As you can see in the illustrations, most of them are in a disastrous state of conservation.

The principal reason for this sorry state of affairs are dangerous removal and restoration procedures, such as:

- cutting of small sections with overly large incisions; in the mosaic of the Drunkenness of Hercules, the cuts represent about 25 % of the total surface area;
- cutting without respect for the mosaic pattern;
- utilization of bitumen, which impregnates to the heart of the tesserae materials and alters them irreversibly;
- utilization of animal glues when treatment is long deferred. Biological processes weaken the glue; the tesserae are no longer held together; thus the mosaics are lost.

Basically, transfer onto inadequate new supports (wax, plaster of Paris, lime mortar, cement)

bears the greatest responsibility for deterioration. Wax can cause fires on occasion; plaster has poor resistance and is effected by humidity; the mechanical resistance of lime mortar cannot bear panels greater than 50 cm/side, so restorers increased the thickness and, correspondingly, the weight. Despite this, the panels broke during transport and maintenance. Iron or wood braces were added, but only increased the weight without avoiding breakage and cracking.

However, the gravest deterioration is due to the use of cement, whether it be mortar, reinforced concrete, or grouting.

When reinforced concrete is used on the back of a mosaic, which generally has been cut up into squares or rectangles, the cement shrinkage causes these smaller sections to buckle. To remedy this drawback, restorers have leveled the mosaic surface by grinding. After this operation, the center tesserae in each section are sometimes reduced to about a millimetre in thickness. The concrete does not adhere well to the tesserae, so the slightest mechanical stress causes thin plaques - the last vestiges of the tesserae - to drop off.

When exposed to heat, the armature swells, provoking tangential stress between the concrete and the tessellated layer, which separates from the support; the mosaic is lost. For example, mosaic N° 121 of the "Recueil Général de la Gaule, Tome I Lyonnaise" suffered from this problem.

In the presence of humidity, the iron oxidizes; the increased volume, due to rust (Fig. 9) provokes tangential stresses with a result similar



Fig. 9 - Mosaic transferred to reinforced cement. Badly insulated steel bars rust and slowly split the cement and the mosaic

to the preceding case.

Utilization of cement provokes another type of irreversible deterioration. As it sets, the cement liberates soluble salts that migrate toward the surface, combining and crystallizing into insoluble compounds in the upper pores of the tesserae; this gives the tesserae a uniformly grey appearance (Figs 10-11). If humidity occurs, salt efflorescences appear; "cleaning" them with hydrochloric acid only increases the damage:



Fig. 10 - Mosaic from the east of France transferred to a slab of cement uninsulated from humid soil underneath. The efflorescence of salts, evident here, very rapidly brings about the destruction of the mosaic



Fig. 11 - Detail of Fig. 10

As long as nitrates remain in a mosaic, we have a substratum with all the characteristics favourable to the development of a biological deterioration process.

3. Intervention

3.1. Technical means:

Unfortunately, removal is involved in most interventions to save mosaics. Since the mosaics are often discovered by chance, we must be ready to move quickly under any kind of atmos-

pheric conditions. For this purpose, we have three trucks which carry tents, compressors, heating systems, and all the heavy material necessary for documentation prior to removal.

Our vast workshop premises include: general workshops (carpentry, mechanical and electrical); a workshop for preparing the transfer; a layering workshop; a design studio; a physico-chemical laboratory; a photographic laboratory; and storage space for documents, inflammable products, bulky materials, heaters, stone, marble... and so on.

3.2.1. Protection

If a mosaic is not immediately removed after its discovery, conservation measures must be taken:

— Protective borders of plaster must be made around the edges of the pavement and the lacunae. Cement must never be used.

— The mosaic surface must be protected against inclement weather by covering it with a layer of sand 5 cm thick, upon which subsequent layers of earth, 5 cm for each degree C below zero, are added (Figs. 12 to 17).

— If possible, a drain should be placed on a level below that of the base support.

3.2.2. Preparation for lifting

The lifting process is preceded by the following preparatory measures:

— When necessary, the area is cleared, cleaned, covered, and scaffolded.

— Running water, electricity and heating are installed; graphic and photographic equipment are set up.

— All stratigraphic and architectural data are collected, and samples are gathered for analysis.

3.2.3. The lifting process

A temporary cohesion system (to reinforce the tessellated layer) is chosen in view of the characteristics of the tesserae and the support, considering as well the deterioration of materials and the site conditions - notably humidity. For the adhesive, we ever more consistently rely on dual component epoxy systems, formulated on the basis of systematic testing. (A detailed description of the use of epoxy resins, with names and addresses of suppliers, is given in the appendix). To ensure the dimensional stability of the mosaic, we use, depending on the circumstances, cotton cloth, fibreglass, or a rigid system - either simple or structured.

When location, time factors and finances permit us to remove a mosaic in one piece, we use either a roller (see Rolf Wihr's report) or a flat framework mounted on rails, such as that employed at Saint-Paul-les-Dax.

Most of the time, however, we are forced to cut and dismantle the mosaics because of site conditions, delay, difficulties in obtaining credit,



Fig. 12 - Saint-Paul-les-Romans, mosaic protected by a polyester shelter, 20 cm of sand, reinforced concrete slabs 80 cm x 60 cm and 7 cm thick, a plastic sheet and a layer of sand 15 cm deep. An upper layer of sand 20 cm thick was added the eighth year. A storm destroyed the polyester covering the fourth year. Roots of bushes have grown through the spaces between the cement slabs, the plastic sheet, and have gone through the sand to penetrate the mosaic

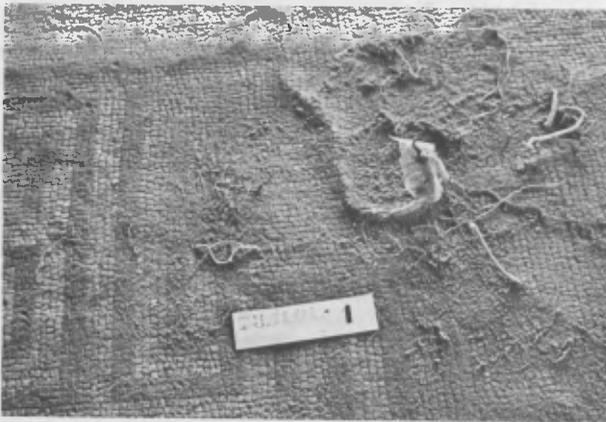


Fig. 13 - Saint-Paul-les-Romans, roots have grown through the tessellatum and the nucleus



Fig. 14 - Saint-Paul-les-Romans, removing the cement slabs, we discover a network of roots and tunnels dug by field mice



Fig. 15 - Saint-Paul-les-Romans, tunnels dug by field mice in the sand and in the tessellatum itself

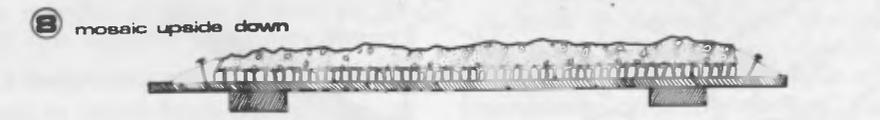
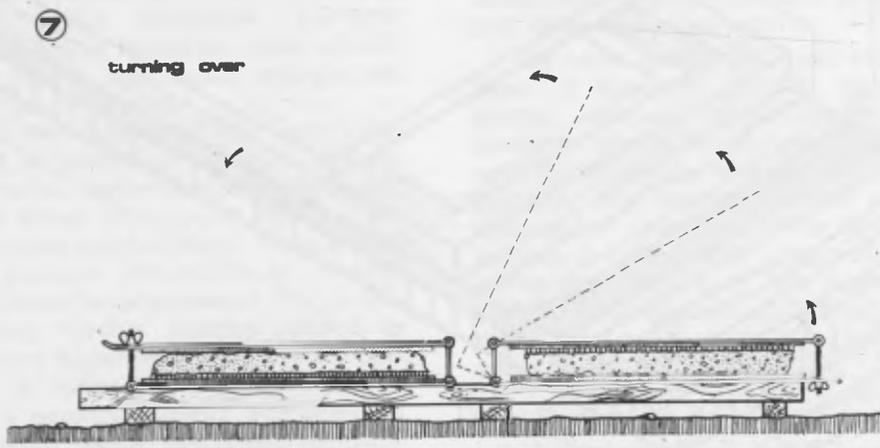
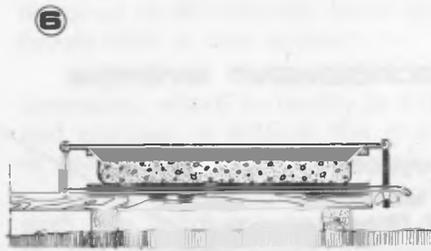
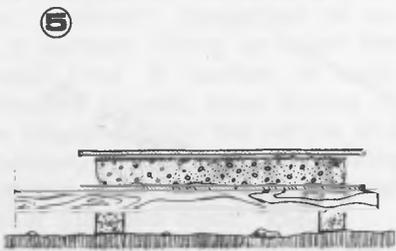
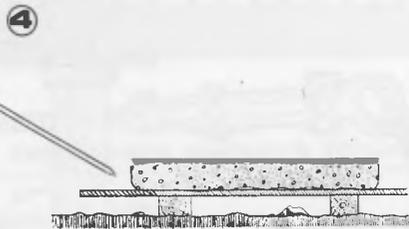
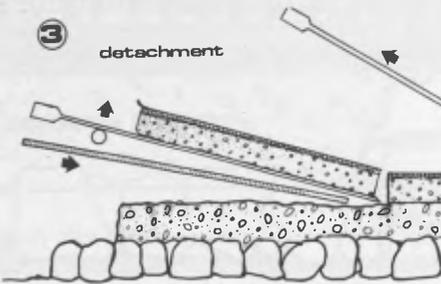
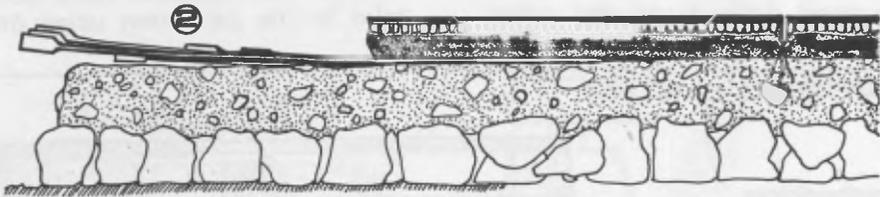
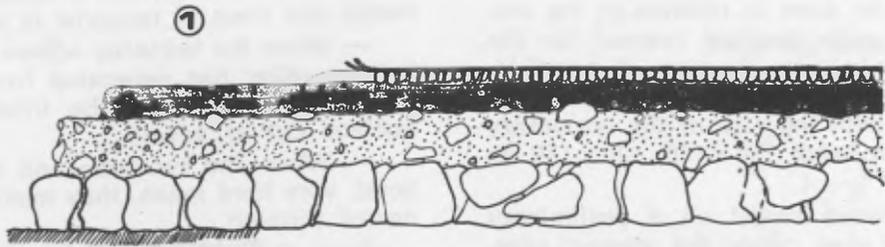


Fig. 16 - Saint-Paul-les-Romans, a mosaic destroyed in spite of protective measures



Fig. 17 - Narbonne, mosaic destroyed by roots

DETACHMENT. FLEXIBLE SYSTEM



the need to transport the mosaics hundreds of miles from the site to the workshop, and the need to store them sometimes ten years or more.

Cutting must be done in relation to the mosaic pattern and with absolute respect for the figured design, whatever its size; if possible, we also try to match the dimensions of the mosaic sections with the size of the temporary support panels on hand: 100 x 150, 120 x 170, or 150 x 300 cm.

Cutting is always based on a preliminary study and a 1/10 plan, called the removal plan.

The cutting method depends on the adher-

ence of the tesserae to the support and the hardness of the support.

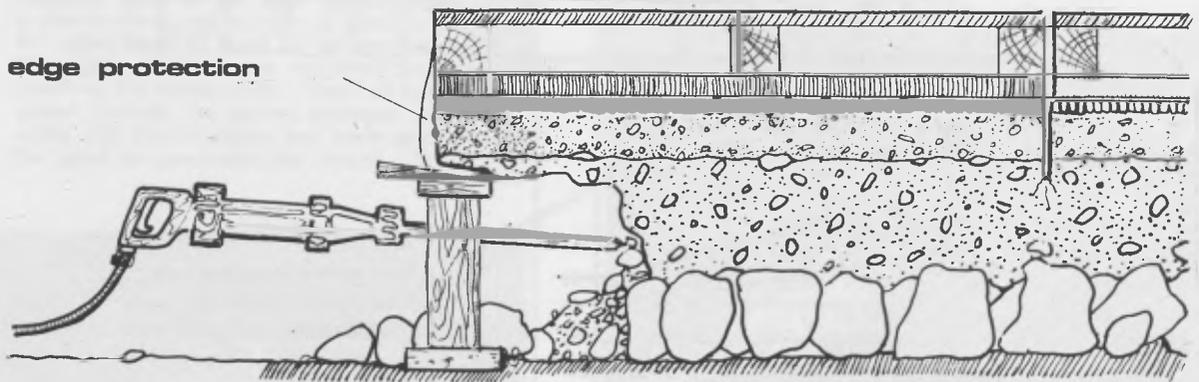
— When the tessellated layer is no longer attached to its support, a simple incision between two rows of tesserae is sufficient.

— When the tesserae adhere to the nucleus, but the latter has separated from the rudus, a row of tesserae must be lifted out and the nucleus cut or sawed.

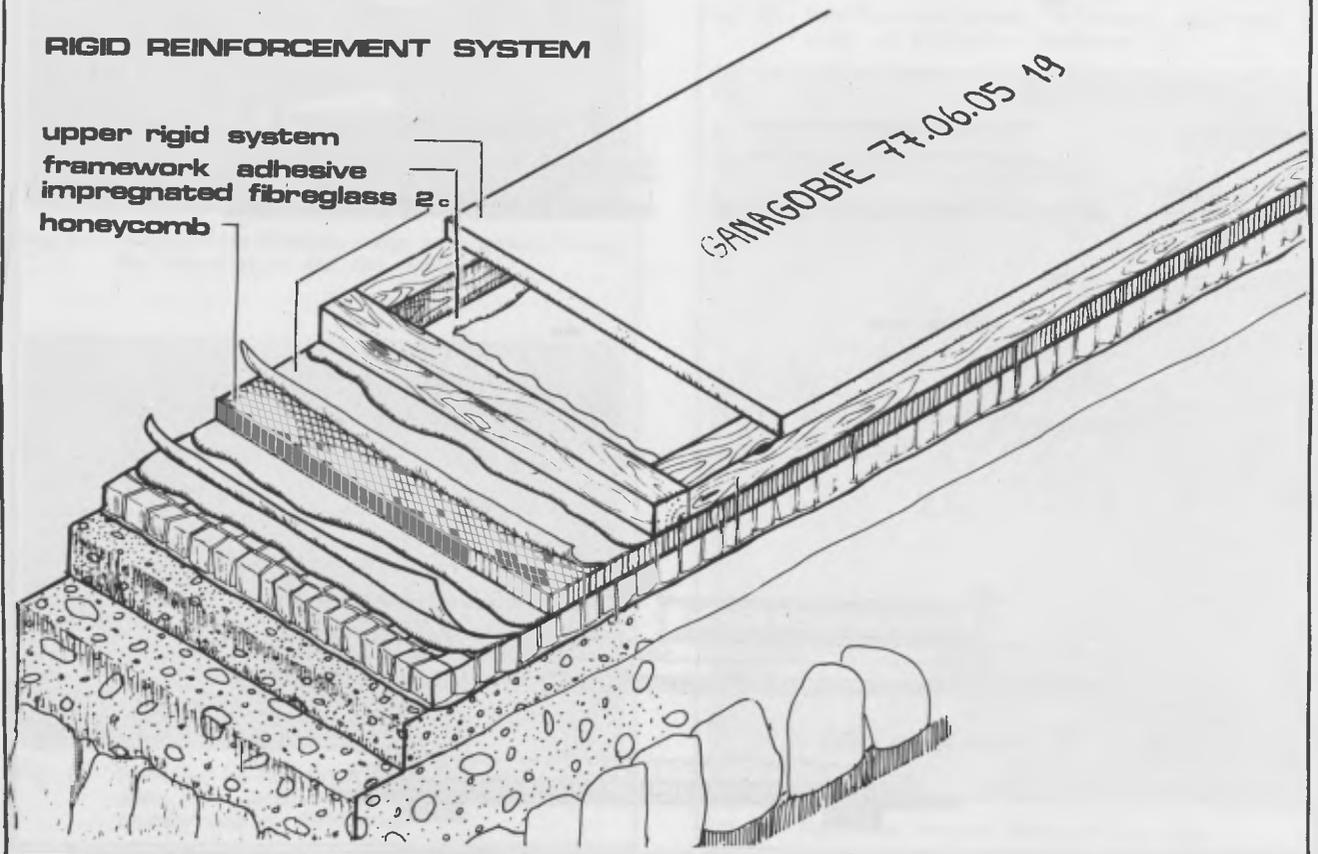
— When the tesserae and support form a solid, very hard mass, they must be completely sawed through.

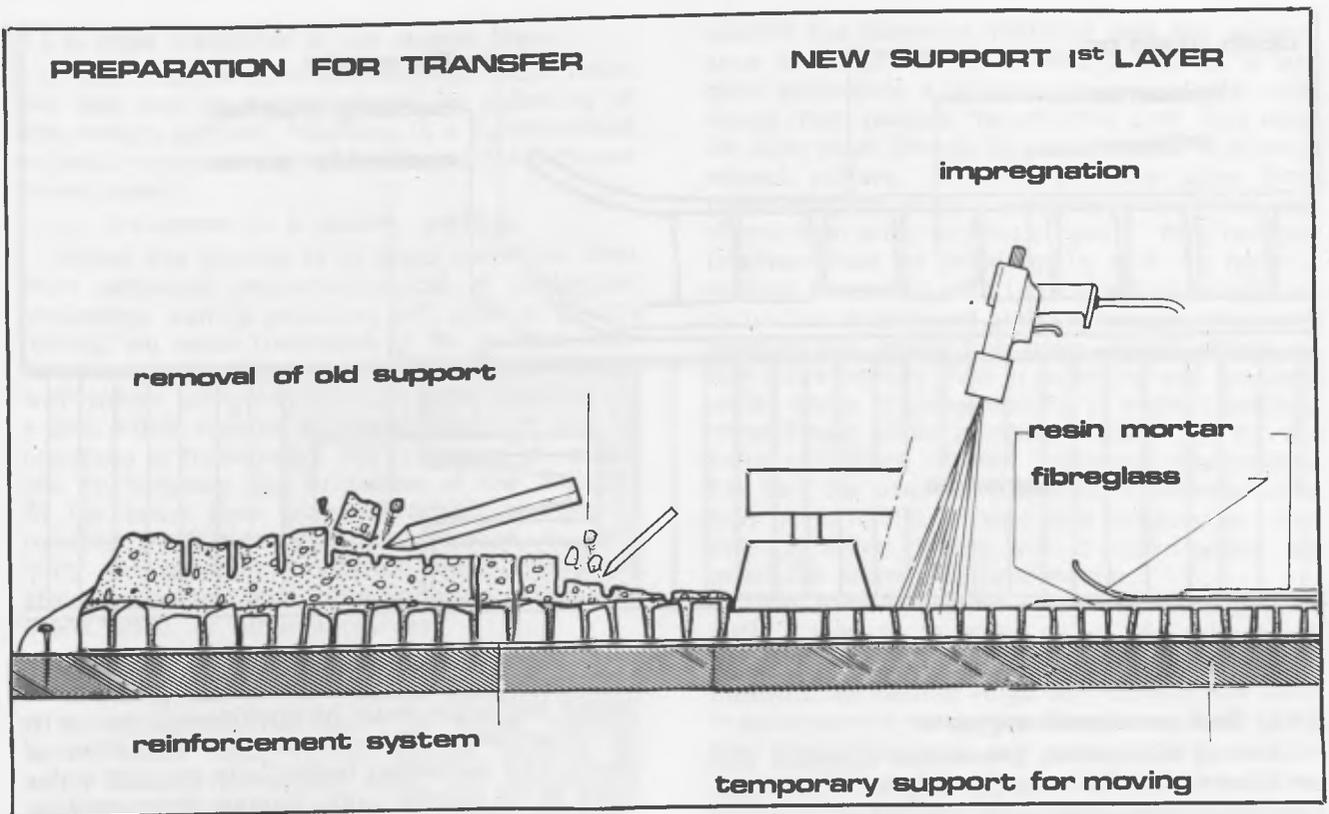
Once the sections have been cut perpendicular to the pavement using one of these me-

DETACHMENT. RIGID SYSTEM



RIGID REINFORCEMENT SYSTEM





thods, we can detach the mosaic from the lower part of the support. Even when the tessellated layer seems to have separated completely from the nucleus, it is extremely dangerous to attempt to detach it without lifting at least the nucleus at the same time. A number of tools can be used to detach a mosaic: steel blades of various lengths or (depending on the nature and hardness of the support) an electric or pneumatic hammer, or an electric or pneumatic saw fitted with carborundum or diamond discs.

It must be said that mosaics are not the only kind of pavements that we encounter; we also find undecorated *opus sugninum*, *terrazzo* decorated with *crustae* or *tesserae*, *opus sectile* of various sorts, etc. In each case, appropriate techniques must be developed.

In this regard, the mosaic of the Ganagobie priory presented a gamut of special characteristics and complex deterioration processes. The treatment of these mosaics is thus an example of conservation methodology. It took several months to become thoroughly acquainted with the work, to observe phenomena and understand their causes; further months passed in tests and laboratory experiments before preparing and placing a temporary support system, which was also a negative mould. The removal itself took only eight hours; the preparation for removal took six months and the placement of the first layer of the support just forty hours.

3.3. Transfer to a temporary support

When a mosaic is lifted from the ground, it is taken to the workshop. There, conservation

tasks mainly consist of clearing away the last vestiges of the old support from the back of the mosaic and ensuring the cohesion of the tesserae of the mosaic layer before it is transferred onto a new support.

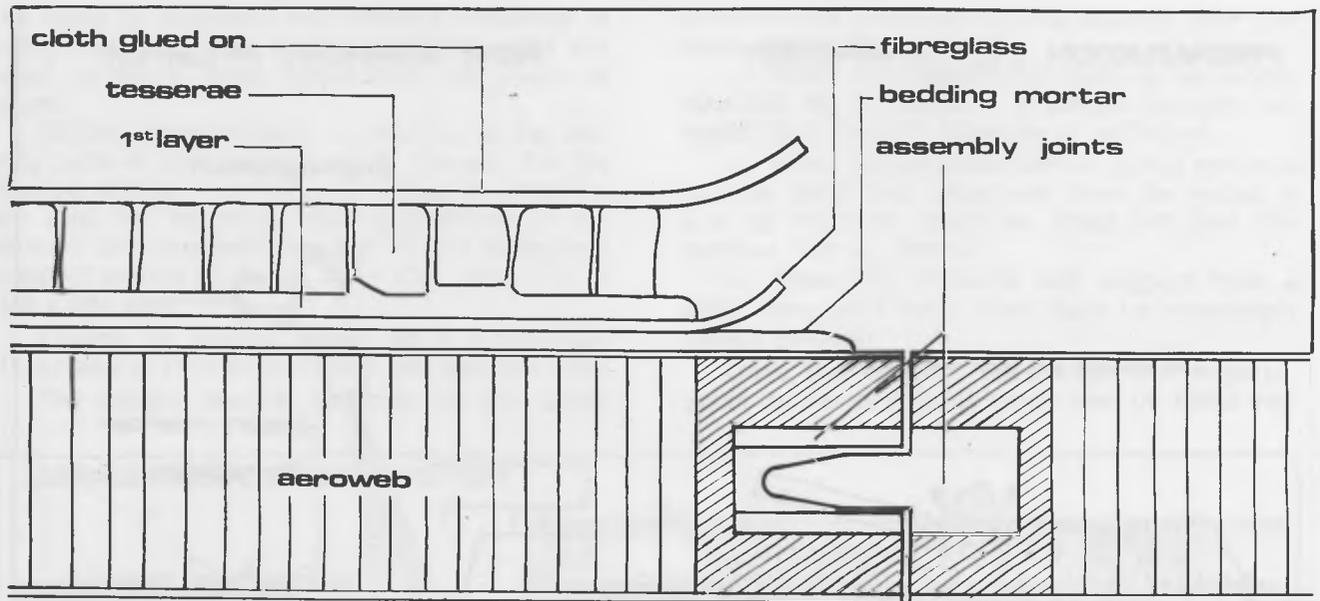
We will not dwell on this apparently simple operation, which in reality is extremely delicate and tedious; it effects the eventual adherence of the new support to the back of the tesserae.

We have attempted to specify new supports with the following qualities: perfect adhesion to the tesserae, high mechanical resistance, light weight, chemical and physical neutrality, and complete reversibility.

We have tested and used scores of different types of supports: plaster, stucco, wood, lime mortar, cement, metal, resins, etc. We have come to prefer epoxy resin mortar reinforced with fibreglass for the primary layer. The advantages of this solution (which moreover has no drawbacks) compensate for higher material expenses in comparison with water-based binders. When this first layer has been positioned, the mosaic sections are stabilized; being in a condition of conservation, they can be stored for years without difficulty.

3.4. Restoration and restitution

"Restoration" of mosaics is often required in order to demonstrate the importance of saving these works. Restoration involves the transfer of the mosaic sections in a condition of conservation onto permanent supports, eventual restitution of lacunae, and treatment of the pa-



vement surface after the cohesion system has been removed.

3.4.1. New permanent supports

Among the various permanent supports that we have tested for museum display of mosaics, sandwich structures offer the best technical characteristics, despite their high cost. They also can be used for on-site display; in this case they protect the mosaics from humidity arising from the soil. Given their thermal inertia and weak heat transmission coefficient, they also reduce the risks of condensation.

3.4.2. Restitution

Restitution of lacunae merits much discussion by itself. In theory, no restitution should ever be made; however, we are sometimes forced to fill certain lacunae for technical, historical or aesthetic reasons. In this case one must be careful not to betray the ancient mosaic. Tesserae materials must be respected - i.e. the

cutting technique and the average statistical dimension. The elements which characterize the laying technique must be considered: regularity or irregularity, dimensions, and the form of joints. Our workshop technicians are not authorized to fill lacunae until, through prior practice, they acquire a "touch" which harmonizes with the original technique. One can always easily distinguish the authentic from the replaced parts because an essential part of our work consists in establishing, during each operational phase, all the graphic records necessary to make this distinction: drawings, photographs, and perhaps moulds. The Lyon Circus mosaic, which you see partially destroyed by fire (Fig. 18) and now restored (Fig. 19), gives evidence of the care that we bring to this operation.

I might add that the need for restitution has led us to deepen our knowledge of ancient technology and to base a new approach to mosaic study on the statistical typology of tesserae.

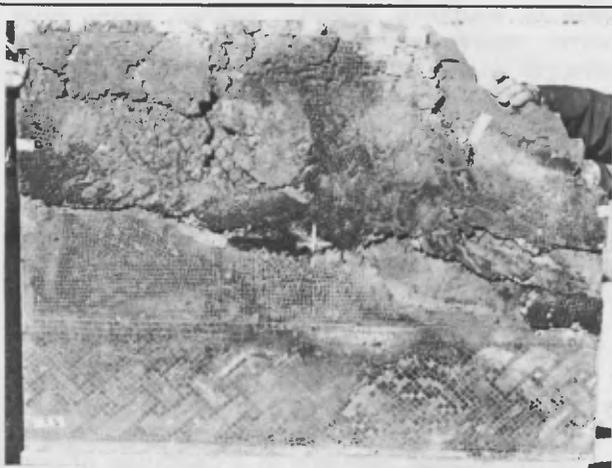


Fig. 18 - Lyon, Jeux du Cirque transferred to cement. Fourth quadriga, state after destruction by fire

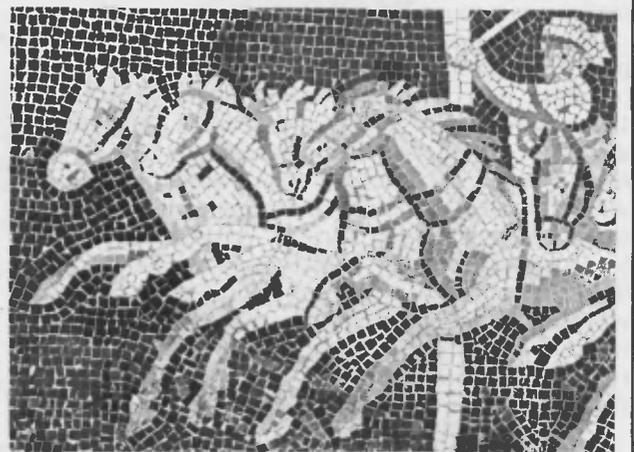


Fig. 19 - Lyon, Jeux du Cirque, after being transferred to a "sandwich" and restored

3.4.3. Final treatment of the mosaic layer

After restitution of lacunae has been made, the last step is treatment and/or polishing of the mosaic surface. Polishing is a controversial subject; however, we must differentiate between three cases:

— Treatment of a healthy surface.

When the surface is in good condition, free from advanced physico-chemical or biological processes, simple polishing will suffice. By polishing, we mean treatment of the surface with abrasive powders (grain size 220 to 420) mixed with water, using felt or cloth pads mounted on a disc which rotates at low speeds. The aim of polishing is to increase the contrast of values and to heighten the brilliance of the colours. At the same time, side diffraction of light is reduced by flattening the microrelief. In antiquity, the polishing operation always followed after the mosaic had been pumiced with sandstone, sand, or other abrasives.

— Treatment of a deteriorated surface.

If the surface of the tesserae is deteriorated, it is sometimes necessary to clean, remove spots, wash, rinse, reduce oxides, oxidize organic bodies, fix soluble salts, and restructure at a scale between a few microns to some tenths of a millimeter.

— Treatment of a very deteriorated surface.

Drastic measures are required when physico-chemical or biological processes (or sometimes both together) have radically and irreversibly

altered the tesserae material and the appearance and legibility of a mosaic. Just as a surgeon amputates a gangrenous leg, so the technician must remove the afflicted part. This must be done even though the aesthetic or historical aspect suffers, or when protests arise from those who are more concerned with formal problems than with technical reality. This removal is often done by grinding; by this we mean a surface treatment with large grain carborundum, corundum or diamond grinding wheels, then with medium and finally fine grain wheels. These rotate more rapidly than in polishing and are used under water. It is necessary to begin treatment immediately after grinding in order to fix the salts and block ulterior biological phenomena. For this we use, for example, a buffered solution at 1/10,000 of zinc and magnesium fluosilicate. After rinsing with distilled water, we grout the joints with lime mortar.

The final operation is a mild polishing, in such a way as to avoid shine and reflections.

Clearly, the methods or procedures I have outlined are neither rules nor recipes, but simply examples of the application of a method. Given the socio-economic and socio-cultural circumstances, these examples constitute a provisional and partial response to certain problems.

One thing alone is important: the pursuit of research, of experimentation, of dialogue. Thanks to ICCROM and all of you, the dialogue is open.

The discussion which followed this lecture will be found on page 81.

APPENDIX

Example of treatment with epoxy resins

Lifting of a mosaic is a process which consists of ensuring perfect cohesion of the tessellated layer with an adhesive system and then separating this layer from its original support. Before applying the temporary cohesion system to the mosaic, one must carefully examine the surface of the tesserae.

The tesserae may be covered with concretions which must be removed; as their structure may be altered they must be reinforced. This reinforcement may be achieved in several ways. If the mosaic is completely dry it may be impregnated with a solution of ethyl silicate. This process is not always easy. On a damp mosaic, we have obtained good results by using a 1 % solution in a non-polar solvent composed of: DY 022, 100 P/wt. *, hardener HY 2954. 45 P/wt. On a dry mosaic we use a solution composed of: AY 103, 100 P/wt., and hardener HY 991, 8 P/wt., which has a very low Gardner index.

The cohesion system is selected according to the humidity and the hardness of the original support. It must be extremely adhesive, either flexible or rigid depending on the situation, and easy to remove afterward. When the mosaic is dry, and the original support is not too hard, we use a flexible process. We apply a layer of adhesive and a sheet of cardboard. If the original support is hard and fragmented, we use a sheet of fibreglass instead of cardboard. If the original support is extremely hard we use the first method. We divide the mosaic into standard size sections by cutting perpendicularly to its surface, and then bind the sections onto rigid panels.

After some experimentation, we no longer use organic adhesive, or most of the composite ones. On a dry mosaic, whose support does not present difficulties, we use an adhesive made from a dispersion of copolymer-vinyl-maleic (Rhodopas AM 041) and an emulsion of unplasticized polyvinyl acetate (Rhodopas A 010). The proportions of the mixture are varied according to the circumstances. We first apply a layer of adhesive. When it has dried we apply a second layer of adhesive on which we place a piece of cotton cloth 0.75 × 1.50 m. We use a cotton cloth of the type 24/18 - 56/74. We then apply another layer of adhesive to the cloth and let it dry. On this last layer we apply a sheet of kraft paper (90 g/m²). This cohesion method has the advantage of being easily removed afterwards, as well as being inexpensive and uncomplicated. On the other hand, it does not adhere to a damp support, and its strength is inadequate if the removal entails great mechanical stress on the

* P/Wt. = Parts by weight.

tessellated layer. It also cannot be used if a water-cooled diamond saw must be employed to remove traces of old mortar from a very hard support.

On a dry mosaic, when removal entails partial demolition of the original support, we use a layer of adhesive composed of Araldite PY 880 and a polyamide hardener HY 800. For a rather rigid mixture we use 50 % weight of epoxide hardener, and for a flexible mixture we use 100 % hardener. On this layer of adhesive we apply a layer of cotton cloth identical to that used with the vinyl adhesive. In certain cases we apply a second layer of adhesive with a layer of Roving fibreglass 150 g/m².

On a wet mosaic, or one exposed to constant humidity, we have used several techniques: GY 250, 100 P/wt., hardener HY 850, 20 P/wt. + HY 830, 40 P/wt., with a layer of Roving fibreglass.

GY 250, 100 P/wt., hardener HY 2958, 15 P/wt., and other formulae derived from the latter with the addition of hardener 943. But these systems are rigid and not easily reversible. Despite this, beginning with the latter formula, we have been able to specify a controllable and easily reversible adhesive procedure for a damp support.

Recently, we were called upon to move a mosaic which had been cemented in 1932 directly onto a 40 cm slab of very hard concrete. The removal seemed impossible and only the creation of a rigid cohesion system enabled us to carry it out. We established a scheme for cutting it into pieces, and fixed the mosaic onto cotton cloth with the 880 adhesive system. We then cut the mosaic at right angles to its surface with a water-cooled diamond saw. We let it dry, then cut out and prepared wood slat panels 0.79 × 1.49 m and 20 mm thick. We sealed them onto the cloth fixture using an Araldite mortar composed of the following materials:

Component A	Part/wt.
Araldite GY 260	100
GY 260 thixotropic	10
Flammex	15
Antimony dioxide	15
Quartz sand	210 (1)
	<hr/>
	350
Component B	Part/wt.
Hardener HY 840	50
	<hr/>
	50

The mixture is composed of 50 Parts/wt. of component B to 350 Parts/wt. of component A, i.e. a proportion of 1:7. To put it another way, 45 Parts/wt. of hardener are used for every 100 of GY 260.

(1) Granulometry: 0.1/0.5 millimeter.

After 24 hours at 20° C. we were able to work on the concrete with pneumatic hammers.

In other cases, after the mosaics have been fixed to the cloth, we establish a plan for cutting them up and moving them, which is traced on the cloth. The mosaic is cut at right angles to its surface, and if it is too hard, it is sawed. The sections are detached from the original support using steel blades of various lengths with handles which can be hammered. These blades may be used manually or with electric or pneumatic tools. The sections which have been removed are placed on temporary supports made of compressed wood fibre treated with fungicide, and are then transported to the workshop.

To ensure the conservation of the detached mosaics, one must completely remove any traces of the original support adhering to the back of the tessellated layer, and replace it with a new support. The old mortar is sawed away to the level of the tesserae layer in successive criss-cross rows at right angles to the surface, with a diamond saw. In this manner it is possible to obtain small blocks which may be safely broken off with a hand or electric chisel. Depending on the hardness of the mortar, this procedure is repeated several times. In certain cases, the mechanical reactions of the old mortar may be greater than the adherence of the tesserae to the system of cohesion. It is then necessary to consolidate the support and the tesserae using an Araldite impregnation. Depending on the circumstances, we choose one of the following combinations:

GY 250, 100 P/Wt. + HY 840, 45 P/Wt. with or without solvent;

GY 250, 90 P/Wt. + GY 250 thixotropic, 10 P/Wt. + HY 830, 30 P/Wt. + HY 850, 30 P/Wt.;

GY 250, 90 P/Wt. + DY 021, 10 P/Wt. + HY 830 + HY 850, 60 P/Wt.;

AY 103 + HY 991, Resin M + HY 956, CY 221 + HY 837, etc.

We then completely remove the original support with paring and pumicing machines, using grindstones of grain 24 to 36.

The new support will consist of a layer meant to insure the cohesion of the back surface of the tesserae to a rigid structure. The first stratum is formed by a layer of Araldite mortar of identical formula to that indicated on page 78, to which we add Araldite pigments of the series DW OII to DN 018 to give it the colour and aspect of the original mortar, and by a layer of Roving fibreglass 250 g/m² of the epoxy-silane type. The sections of mosaic are heated beforehand under infra-red lights to 35° C.; the Araldite mortar is also heated to 35° C. in a warm water bath and then catalyzed at 40° C. under infra-red lights. The sections of mosaic prepared in

this way must have a uniform thickness for each pavement.

This first layer is solid enough to permit the conservation of the mosaic sections - in a museum storeroom, for instance. On the other hand it is insufficiently strong to allow the restoration of the mosaic. The mosaics may be prepared for restoration by sealing the sections onto a support which has all the necessary qualities. The numerous difficulties encountered in the "permanent" setting of mosaics have led us to prefer transferring mosaics onto light and lasting supports. For the new supports we generally use panels composed of a light, cellular honey-comb layer sandwiched between two stratified sheets of fibreglass and Araldite, called Aero-web or Aerolam. These supports are manufactured by Bonded Structures according to the specifications for their particular application. We use supports from 35 to 55 mm thick, measuring on the average 1.5 x 3 m, though it is possible to obtain any thickness or dimension. The resins of the outer sheets are fireproof. These supports are cut with an electric saber saw, which has special blades for hard materials, then glued together to obtain panels of the same dimensions as the mosaic being restored.

The gluing of the sandwich elements is done with an Araldite base adhesive used at 20° C., having the following composition:

Component A - Epoxy	Part/wt.
GY 260	100
Thixotropic agents	10
Flammex	20
Antimony dioxide	20
Colouring agents	2
DW series	
Silicate sand (1)	248
	<hr/>
	400
Component B - Hardener	Part/wt.
HY 840	45
Thixotropic agents	2
Colouring agents	3
DW series	
Silicate sand (1)	150
	<hr/>
	200

The components are heated to 30° C. and are mixed in a proportion of 2 parts A to 1 part B, the pot life being approximately 40 minutes. In this way we assemble the support panels into a single support element measuring 3.50 x 7.00 m. If the mosaics are even larger than this, we make several panels which are then connected with special joining elements.

We then trace the layout onto these panels with a margin of error of approximately 0.3 mm. After this we check the sections of mosaic set in their first layer of Araldite mortar backed

(1) Granulometry: 0.1/0.5 millimetre.

with fibreglass, the fixing cloth having been removed, and determine their final placement. The support panels are treated to remove the agents used to separate them from their moulds. The mosaic sections are well positioned, aligned and leveled, and then sealed onto the Aeroweb panels with an Araldite mortar identical to that used for the first layer.

The temporary cohesion system is removed either mechanically when the panels have set, or by heating the fixing cloth with hot air at 100° C. from Leister type thermostat turbines.

Lacunae and small holes are repaired with antique tesserae which have been restored and cleaned, or with new tesserae identical to the old ones - using an Araldite base adhesive of the following composition:

Component A - Epoxy	Part by Wt.
GY 250 epoxide	250
Thixotropic agent	50
Flammex	40
Antimony dioxide	40
Colouring agents	20
Quartz sand (1)	600
	1000

Component B - Hardener	Part by Wt.
HY 840 hardener	550
Bentone	200
Colouring agents	20
Quartz sand (1)	230
	1000

The mixing of the two components is proportionately 5 parts A to 1 part B, and is effected at 20° C. The pot life is approximately one hour. Permanent hardening by catalysis of the mixture is obtained by heating it for one hour under infra-red light at 50° C.

Next, if necessary, the mosaic must undergo physical or chemical treatment to consolidate the structure of the materials which compose the tesserae. We then grout the joints with a mortar identical to the original. The mosaic is polished and pumiced with supple discs of 320 grain. Finally the mosaic is impregnated with a fluid silicone oil, such as SI 200, to increase the colour contrast, prevent soiling, and facilitate eventual upkeep.

Another example of the use of resins is given below. A floor of lime concrete and brick with a very interesting decoration of black marble tesserae is discovered beneath a 5th century mosaic. The lower one must be saved from immediate destruction. The concrete of the floor is fragile and thoroughly soaked. We cover it with a clay paste, and then apply a strong layer of reinforced plaster. We then separate the lower part of the pavement and replace it with

a layer of reinforced plaster. On the plaster we seal a grid of 40 mm iron T bars. Then the mosaic, "wrapped" in this manner, is bolted between four standard I beams, each 200 mm thick. The whole thing weighs 3 metric tons, and is lifted by a crane and transported to the workshop. We lay it upside down on the floor, remove the iron armature and reinforced plaster from the back, and let it dry. The concrete is too rough and fragile to be demolished without great care. We impregnate it with a solution of Araldite BY 156 (100 P/wt.) and HY 2.996 (26 P/wt.). Then we cut it with a stone saw, and impregnate it again. We repeat this procedure ten times. All that remains is 20 mm of the old concrete, which is perfectly attached. It is cleaned, pumiced, and leveled with Araldite mortar. We then seal it onto an Aeroweb panel. The mosaic is turned over, and we finish "undressing" it. It is now intact and solid with no change in appearance.

Conclusion

The previous indications are examples of the most frequently used procedures, but there are certainly others. The general approach of other methods of conservation and restoration could be drawn from this frame of reference. Nevertheless, I would like to add that, thanks to the extraordinary properties of the epoxy resins, we have been able to develop a series of procedures which have permitted us to save large numbers of mosaics previously considered as good as lost. The testing and use of epoxy resins constitutes a form of technology particularly suited to conservation technicians and restorers.

Names and addresses of suppliers

Brand	Product	Supplier
Araldite Aeroweb	resin and hardener panels	Prochal 5, rue Bellini 92806 Puteaux, France
Rhodopas	vinyl emulsions	Rhone Poulenc 25, quai Paul Doumer 92400 Courbevoie, France
Flammex	fire proofing agent	Nobel Hoechst Tour Nobel 92800 Puteaux, France
Antimony-dioxide	fire proofing agent	Societe des mines de la Lucette 4, rue de Rome 75008 Paris, France
Ethyl silicate	product for hardening stone	Promecome 68, avenue du Général Michel Bizot 75012 Paris, France

(1) Granulometry: 0.1/0.5 millimeter.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions. We have, however, tried to record the essential points, thus showing the general direction of the discussion which followed the lectures of Herr Wihr and M. Bassier.

M. Ennaifer: We thank you very much for this interesting presentation.

Mlle. Gamsou: I would like to ask Herr Wihr what is the preferable adhesive for mosaics, Vinavil?

Herr Wihr: We use a solution of polyvinyl chloride. Its trade name is Mowilith 35/73. It's a completely transparent product which holds well and is flexible but not too much so.

Mr. Novis: I would like to congratulate Herr Wihr for having tried this technique. I've never had the courage and besides I know someone who failed in trying it. Does the pavement stretch when it is rolled because of particles slipping between the tesserae?

Herr Wihr: I know what you mean. I've asked Stefano Locati the same question and he told me there's no danger. I've never noticed any enlargement. I've not lost a single tessera. Besides, the spaces between the tesserae aren't hard to clean.

Mrs. Alexander: How do you use your rolling method on a room mosaic when the pavement goes right up to the wall? How would you place your drum in such circumstances?

Herr Wihr: We remove a band of 10 cm all around the edge of the mosaic, gluing it on cloth beforehand, so that there will be enough space for the wheels of the drum.

M. Ennaifer: Have you ever cut a mosaic after you've rolled it on the drum?

Herr Wihr: Yes, in the second example in my talk I showed how we cut the mosaic after rolling it. By that method we avoided the loss of tesserae.

M. Ennaifer: I would like to thank M. Bassier for his extremely interesting report. Archaeologists and art historians warmly welcome the assistance of skilled technicians and wish that

there were more of them. I'd like to ask what these operations cost.

M. Bassier: Before answering your question, I'd like to make clear that my studio, although working exclusively for the Ministère de la Culture, is a private workshop. It has total responsibility for all the operating costs: the building, insurance, investment, the purchase of tools and materials, research, the training of staff. It has to pay duties and taxes. It has to pay suppliers, and above all, it has to pay a highly qualified team and their social benefits as well. Under these conditions, the work of saving, conserving and restoring mosaics to museum conditions can cost, in time, from 40 to 60 hours a square metre. Add to this our supplies and materials and the amortization of our facilities and you reach the amount of 4,000 to 10,000 Francs the square metre. I might add that we will work on mosaics as far away as 700 km from our studio.

M. Ennaifer: Is it difficult - in some countries - to get the necessary materials?

M. Bassier: The manufacturers of the products we use sell them in all the countries of the world, but some countries prevent the purchase of these products in different ways, in order to avoid paying for them in hard currency.

M. Ennaifer: I would like to know whether, after fifteen years of using synthetic resin supports, you have noticed any problem of stability or durability? And also, can you tell us whether you find any disadvantages in using older methods?

M. Bassier: I would reply that we have used and tried all known methods and that we are continuing to experiment with new methods. It's the project and the means available which determine the method to follow. Certain products and processes should be avoided, in their traditional use, or forbidden. There are processes cheaper than those I've shown you, and just as efficacious, with certain reservations. If you could be absolutely sure of the future state of a mosaic, protecting it from all dampness and all mechanical stress, lime mortar would be the ideal material for a support. You can also transfer parts of a mosaic, with a first coat of epoxy resin strengthened with fibreglass, onto slabs of reinforced concrete which could have been

prefabricated independently a year earlier. The surface of the slab would have to be adjusted to the individual mosaic placed upon it. Usually technicians don't pay enough attention to the distortion of reinforced concrete slabs. When we began to use epoxy resins, we made the same mistake. The mosaic of the Athlètes Vainqueurs at Vienne curves inward 0.02 m every 7.40 mm; in 1977 we tried to correct it with heat but that's impossible on a cement slab. To prevent the problem of contraction and sagging, we no longer use elements having a surface greater than 15 square metres and we balance the pressures equally on both surfaces of the element.

M. Laffont: Here's a problem: Even if the surface of a mosaic is perfect before being detached, should it be polished?

M. Bassier: The decision to pumice or to polish a mosaic is very difficult to make. First of all, in antiquity, mosaics were pumiced and polished. Texts of the time tell us this. We have found mosaics which still partially preserve their original polish. The appearance of a mosaic when it is discovered is most often that of a mosaic altered by physico-chemical and biological agents, particularly when humidity is present. Some people think that this appearance should be preserved for historical reasons. We should not forget that this is not what the mosaic looks like but what the factors that have changed it from its original state have left it looking like. Examination with a microscope enables us to determine the importance and depth of these changes. When they are irreversible, when they hinder the legibility and the preservation of the document, they must be removed. That's what a dentist does with his drill to "restore" a tooth with cavities. We're sometimes forced to do that. It can mean removing one or two mm from the thickness of a tessera. We don't systematically do that. It's a drastic operation which we try to avoid if at all possible. When it is necessary, it must be done in such a way that it will never again be necessary to repeat it. Sometimes we only polish them, using stones wrapped in cloth and very fine powder, in order to preserve the "relief" of the mosaic and improve the contrast

and the brightness of the colours. To pumice a mosaic is less dangerous than to leave it to weather unprotected for ten years. At Tivoli I've found that some tesserae are only 4 to 5 mm thick, half of their original thickness.

To reply to your question, M. Laffont, if a mosaic is perfect before it is laid down, there's no reason for pumicing it. We've just relaid a mosaic of the 1st century B.C. at Perigueux and we've saved its mortar and natural patina.

Mr. Schwartzbaum: Don't you sometimes also remove the layer of resin, polishing the surface mechanically, or do you have reagents or special solvents?

M. Bassier: We use resins which soften at 60° C. Although we don't use them to remove epoxy resins from mosaics, there are solvents specifically for epoxy resins, called Wehasolve.

Sig. Mora: I can't agree that an electric saw should be used for cutting.

M. Bassier: You're perfectly right. We use the saw only when it is absolutely necessary. But we have to face the facts. When you're removing a mural, which is rare, it's because, usually, the support is in a very bad condition. Because of that, the painting comes off very easily. In the case of mosaics, the mortar is often in an excellent state. It measures 10 to 20 cm in thickness. Removing the mosaic is necessary and urgent because of factors which are going to destroy it. The mosaic has to be loaded on a truck, moved and stored perhaps ten to 15 years before receiving any treatment. We have more than 1,000 m² of mosaics in our studio awaiting restoration. We have to be prepared to saw when the circumstances require it. You've just now seen mosaics destroyed by a mosaicist who didn't know how to use the saw and we've seen here in Italy mosaics cut out with a saw.

M. Ennaifer: I thank everyone who has taken part in this discussion. A great number of problems have been raised, new supports, the cost of treatment, pumicing, etc., which certainly must be brought up again and studied further at another meeting.

THE PROBLEM OF LACUNAE IN MOSAICS

by Paul Philippot

Translated from the French
by Elizabeth Schwartzbaum

Introduction

The specific characteristics of mosaics - both wall and pavement mosaics - obviously do not involve a different method of approach to the problem of lacunae than that formulated in general terms by the modern theory of restoration. The *principles* already outlined for monuments in the 1931 Carta del Restauro and in the 1964 Venice Charter, as well as the fundamental considerations of Cesare Brandi (1) are, in fact, applicable, in the current viewpoint, to all forms of artistic creation. Nevertheless, the means of applying this method vary according to the type of object under consideration, and each domain requires, in order to meet in an adequate fashion the general fundamental exigencies, the perfecting of special formulae. Although there exist today dominant methodological principles, we still lack any universal recipes. We will briefly outline these fundamental principles at this point, before attempting to sketch those aspects of the problem which are particular to mosaics.

General theory of the treatment of lacunae

In accord with the modern theory of restoration such as is generally accepted today, and such as is practiced more and more in fields where restoration, thanks to a longer critical tradition, has become more rigorous (we refer especially to paintings and archaeological objects), the problem of lacunae must be confronted with the basic need to reconcile the historical viewpoint, according to which the work of art is essentially a document, with the aesthetic viewpoint, according to which it is a formal creation. Only by reconciling these two methods of approach, both of which compel recognition because of the double historic and aesthetic quality of the work of art, can the authenticity of the work of art be respected.

From the historical point of view, nothing can

justify an intervention on the lacunae, which constitute a document, because such an intervention would necessarily entail an alteration of this document. If the document is to be interpreted, if a good comprehension of it requires a conjectural reconstruction, this should always be done separately, in the form of an explanatory documentation, and never on the work of art itself. Similarly, even when the philologist hypothetically completes the lacunae in a mutilated text, he does it in the editing of the text, according to precise conventions intended to avoid all confusion, and never in the original manuscript.

On the other hand, from the aesthetic point of view the lacuna, interrupting the continuity of the form, renders the reading of the form more difficult, and it is henceforth evident that an intervention on the lacunae should, in certain conditions, allow the re-establishment of a better reading of *the original*. However, in order to respect the authenticity of the original, the intervention must be limited to carrying out the suggestions implicit in those parts preserved (Fig. 1), stopping as soon as hypothesis begins,



Fig. 1 - A suggestion of the general plan

and adopting a process which allows that by careful examination one can always easily distinguish the intervention - critical interpretation - from the original. To this end, various formulae have been experimented with in different fields with varying degrees of success (Fig. 2). There evidently does not exist any universal rule which could automatically be applied. The requirements of the theory can be realized in each actual case only through a sensitive interpretation of the individual work.

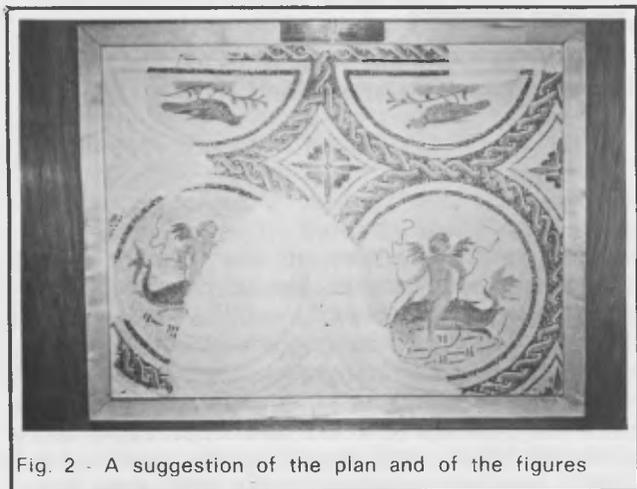


Fig. 2 - A suggestion of the plan and of the figures

Lacunae in mosaics

Generally speaking, the specificity of the problem posed by mosaics derives on one hand from the special ties with the architecture of which it is an integral part, and on the other hand from the technique which characterizes it and which determines its texture and its reaction to light. The first condition is analogous to that which applies to mural paintings; one could therefore extend to mosaics the considerations developed for the treatment of lacunae in mural paintings (2). The second condition, however, is strictly peculiar to mosaics and will require a special examination.

The first distinction necessary, which permits the application of the same criteria for mosaics and for mural paintings, is the distinction between the lacunae which cannot be reintegrated by a reconstruction and those for which such an intervention can be envisaged.

The principle according to which reintegrations is justified only when it involves no hypothesis, must be completed by the following considerations:

1. Even when the reconstruction is not hypothetical, as in the case of a solid group or of a decorative motif which repeats itself exactly, the extent of the lacuna must nevertheless be taken into consideration. In effect, even the most nearly perfect reconstruction cannot pass certain quantitative limits, without asserting its

self on the general impression and thereby distorting the original instead of setting it off.

2. Lacunae are appraised differently when the work has remained *in situ* and when it has been transported to a museum or warehouse. *In situ* the work naturally presents itself as an integral part of the architectural ensemble, and the lacuna must therefore be appraised in relation to this context. Thus, a lacuna perfectly acceptable in a fragment which presents itself as such in a museum, can become very offensive if it gives the effect of a hole in a decorative system framing the architecture. Such a situation could then, exceptionally, justify a more extensive reintegration. We refer here to the principles developed for mural paintings (3). In the case of wall mosaics special attention must be given, in this regard, to the luminous quality and to the methods of lighting of the interior space. Old systems of lighting were generally much weaker than that to which we are accustomed. It would be catastrophic to project our modern requirements into ancient interiors, all the more since, as one can easily ascertain, as light grows weaker, the forms become more integrated into the ambient space, while as the light grows more intense and more directed, forms and things become more isolated in their materiality. Thus, colour reproductions of mosaics made, for technical reasons, under a lighting much more intense and oriented than the original lighting, completely falsify the effect sought by the artist. In the same way, modern lighting cannot help making lacunae conspicuous, whereas the half-light of the ancient lighting systems integrated them much more easily into the unity of the interior atmosphere, where the image in mosaics reveals itself slowly, like a progressive apparition. One should therefore attempt to make the best of the lighting before deciding upon an intervention on the mosaic itself.

Reintegratable lacunae

When, within acceptable limits, it is decided to reintegrate the lacuna, the problem arises of reconciling this reintegration - justified only as a setting off of the subsisting original by a re-establishment of continuity - with the requirement of historical criticism which holds that the interpretation can be distinguished as such under careful examination, in order to avoid all risk of falsification.

An immediate result of the preceding considerations is the fact that today one can no longer accept a reconstruction executed with old tesserae or even with modern tesserae which attempt to be indistinguishable from the original. Indeed, this type of retouching, of which the mosaics of Rome offer numerous examples, appears today, less than a century later, as a "romantic" falsification.

Even when it is a question of a unified surface - such as white, blue, green or gold grounds - one should remember that the placing of the tesserae is determined by the creation of effects of light reflection, and that modern setting can never recapture the infinitely subtle play of the original setting but always stands out offensively because of its mechanical, hard quality.

The attempt to reconcile reconstruction with visibility of retouching by sketching the forms with masses of soft colours, applied in paint on a smooth surface at the level of the tesserae, as in the nave of Santa Maria Maggiore, is hardly satisfying, for it creates a real optical disorder which extends to the original without, however, reintegrating the lacuna.

Given the importance in a mosaic of the play of the surface texture obtained by means of the tesserae (cut, form, material, angle of setting), it seems that research should be oriented toward a solution analogous to that of *tratteggio* in paintings, that is, towards a use of tesserae analogous to the original but nevertheless different, capable of assuring a sufficient integration while at the same time remaining slightly distinguishable by their material. A distinction in the material rather than in the system of setting seems required, since it is precisely the *staccato* resulting from the setting of the tesserae that is the determining factor in the rhythm of a mosaic, the continuity of which must be re-established by the reintegration of the lacunae. Once the distinction has been assured by the material itself (which could, for example, give a softened reflection of light), there is nothing to oppose a very highly developed reintegration, as long as it is a question of a small lacuna, the reintegration of which involves no hypothesis. To our knowledge, however, no experiments have yet been attempted in this direction.

Non-reintegratable lacunae

When, because of its dimensions or its location, a lacuna is not reintegratable, there remains the problem of presentation, since one must always reduce as much as possible the disturbance caused by the lacuna in order to reinforce the unified effect of the whole. Once again, inspiration is drawn from the general considerations on the treatment of lacunae developed by Cesare Brandi based on the Psychology of Form according to which our perceptions always take the shape of relations between a figure and the ground against which it stands out (4). Non-integrated lacunae should therefore be treated so that they do not "cut a figure" on the image as a whole, which then recedes to the status of a background, but on the contrary so that they constitute the ground against which the fragments of the image stand out reunited. In practice, one could draw inspiration in this

regard directly from the experiments carried out in the domain of mural paintings (5).

Whether it is a question of pavement mosaics or wall mosaics, the most satisfactory solution definitely appears to consist in treating the lacuna like a layer of *arriccio* uncovered by the falling of the *intonaco* and the tesserae. The slight recess in relation to the plane of the tesserae, as well as the texture and colour of the material, judiciously chosen in imitation of or inspired by the original *arriccio*, allows the perception of all the lacunae as parts of the same ground plane *in front of which* the mosaic image stands out clearly, without risk of interference or of confusion (Figs. 3, 4). It is therefore necessary on the one hand to take care to treat all of the non-reintegrated lacunae in the same way, in order to insure the unity of the ground plane, which becomes the mural plane of reference; and on the other hand to prevent at any cost the necessary reinforcement of the edges of the lacunae from standing out as an independent figure between the tesserae and the ground. In regard to the latter, especially as concerns wall mosaics, it should present a colour and texture which allow it to be as well



Fig. 3 - Missing tesserae leave the original setting bed exposed

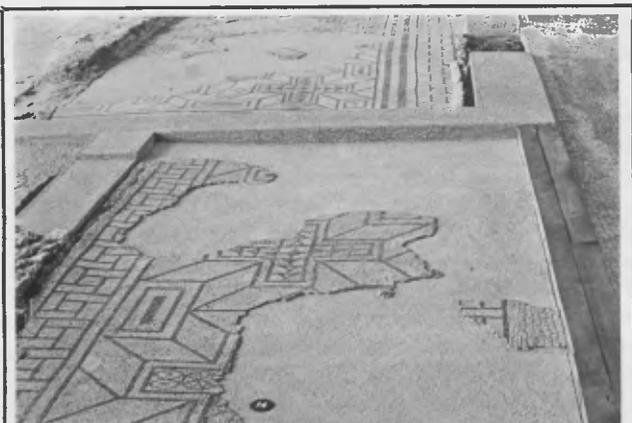


Fig. 4 - The lacuna is filled with a slightly depressed surface resembling a setting bed

integrated as possible, slightly recessed, into the optical web created by the tesserae in the proper lighting. This is a matter, as one can imagine, of a very delicate choice, which requires a great aesthetic sensitivity on the part of the restorer, and which is made even more difficult by the modifications of tone that occur as the preparation dries. An error of texture or of colour - as in the case of the brick-red lacunae of the rotunda of St. George in Salonica - inevitably results in displaying the lacuna as a figure instead of making it recede to the status of background.

Two formulae often met are, in our opinion, to be avoided because they do not allow in any case the spatial solution just described. These are:

1. The revealing of the wall in lacunae, showing stone or brick in its brutal and direct materiality, in violent contrast with the formal reality of the optic web created by the tesserae, with the result that the wall, instead of serving as ground, "cuts a figure", to the detriment of the mosaic image. This can be seen in certain parts of Kariye Djami where restoration has left the brickwork apparent (Fig. 5).



Fig. 5 - The lacuna has not been filled and leaves the naked wall exposed



Fig. 6 - The lacuna is filled with a glossy surface

2. The treatment of lacunae with a smooth preparation, which reflects the light too harshly in relation to the diffusion caused by the mosaic tesserae, thus causing a contrast detrimental to integration. This solution was also tried at Kariye Djami, where it is all the less satisfying because it is adjacent, incoherently, to the preceding solution (Fig. 6). It should also be pointed out that the addition of a painted colour generally runs the risk of aggravating the situation with a glazed effect. One must always try to



Fig. 7 - The lacuna is filled with a rough surface

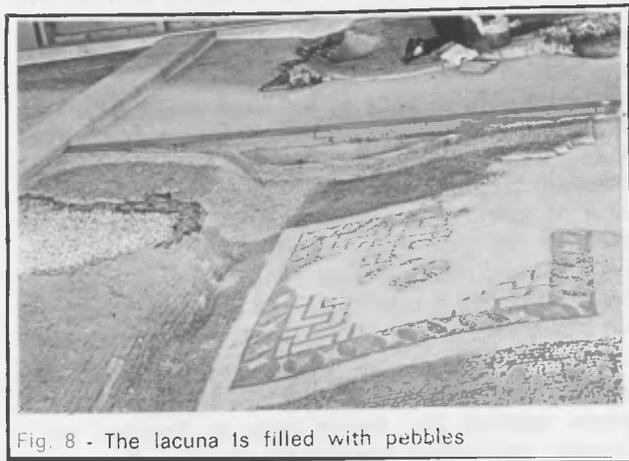


Fig. 8 - The lacuna is filled with pebbles

obtain the desired optical values in the colour and texture of the preparation itself, by selecting the proper inert substance.

In the case of pavement mosaics, treatment of non-reintegrated lacunae is obviously simpler

because the constitution of the plane of the lacuna as the ground plane of the image is less subtle and less delicate (Fig. 7). On the other hand, one could cover the *arriccio* with a layer of graded gravel adapted to the dimensions of the tesserae, in order to reinforce the idea of earth (Fig. 8). This supposes, however, that the visitors will not walk on the mosaic.

The discussion which followed this lecture will be found on page 88.

Notes

- 1 Cesare Brandi, *Teoria del Restauro*, Rome, Edizioni di Storia e Letteratura, 1963.
- 2 Paolo and Laura Mora and Paul Philippot, *La Conservation des peintures murales*, Bologna, Compositori, 1977, Chapter XI and bibliography.
- 3 *Ibid.*
- 4 Cesare Brandi, « Il trattamento delle lacune e la Gestalt-psychologie », *XX International Congress of the History of Art, Acts, Problems of the 19th and 20th Centuries. IV Studies in Western Art*, New York, 1961.
- 5 See note 2 above.

DISCUSSION

These notes do not attempt to reproduce word for word the many comments and questions which followed M. Philippot's lecture. We have, however, tried to record the essential points, thus showing the general direction of the discussion.

Sig. Mora: The method of approach to the problem of lacunae in mosaics doesn't differ from that expressed in general terms in the theory of restoration. These principles are applicable to all artistic disciplines.

But even if we have methodological principles, we don't have universal formulae. We must apply theory to practice and, in the specific case of wall or pavement mosaics, there are problems which differ from those of other art forms.

Speaking generally, the theory of restoration has acquired a certain rigidity regarding the problem of lacunae in paintings and archaeological objects. We must face the problem of reconciling the historical point of view, for which the work is a document, and the aesthetic point of view which sees it as an art object. Only by reconciling these two diverse ways of approaching the work can we be sure that its authenticity will be respected.

There are no new formulae to follow, only general outlines.

I would like to ask Mr. Novis how he handles lacunae.

Mr. Novis: In the case of mosaic pavements, I normally fill little gaps with tesserae taken from the outer borders. In this way, the tesserae around these internal lacunae are reinforced. This technique avoids a moth-eaten appearance and also prevents the loss of other elements. This system has already been accepted by others and I hope that it will be here too.

Sig. Mora: That seems very logical to me, rather than filling these spaces with other materials. But it would be better to do it with tesserae whose original placement is unknown.

Mrs. Alexander: Some future discussion on lacunae in mosaics *in situ* would be a great help. In Tunisia, the situation is such that there are hundreds of mosaics which cannot be removed. I hope that you will give this problem your attention.

Mr. Novis: I've often judged it necessary and convenient to set three new rows of tessera along the destroyed edges of mosaics *in situ*, or around lacunae, in order to prevent further deterioration. It's a way of helping, can be done in very little time and costs little but it should be done only on a mosaic in good general condition.

Sig. Robotti: In regard to the preservation of mosaics at their sites, and the restoration of missing parts, I think it's essential that we refer to the basic recommendations contained in the

International Charter of Restoration, that is, the Charter of Venice 1964, and in the Charter of Restoration 1972. In regard to the first problem, we should resort to transferring a mosaic to a museum only in case of absolute necessity. This brings up several preservation problems, besides those of legibility and of presentation. In treating lacunae, we should exclude the restoration of images because that would mean a return to the practices of the 19th century. The difficult and really urgent cases, however, should be studied by a committee of experts to decide on the best way to avoid the errors of the past.

Mr. Schwartzbaum: Perhaps you could apply to certain problems encountered in Tunisia the same method Mr. Novis uses in England on a mosaic pavement preserved *in situ*. A general consolidation was done and the mosaic was recovered with earth after documentation.

M. Bassier: It's always desirable to preserve mosaics in their archaeological context whenever possible. Unfortunately, we often have only a few hours before they're destroyed by bulldozers. Besides, they must be protected against the weather and against dampness coming from the soil. That's why moving mosaics is unfortunately often the only solution.

M. Ennaifer: We encounter similar conditions in Tunisia.

M. Bassier: The problem is simple. Either mosaics are exposed to the destructive agents described by Dottoressa Velocchia in her paper, and the mosaics keep changing under their effects until they are totally destroyed, or the mosaics are protected from such damage and their preservation in a museum or *in situ* can be assured.

Some "conservation methods" *in situ* are too often an absence of method. They tend to hide the causes of change without remedying them. In less than a century, if we don't take care, the mosaics exposed to the weather without any protection will have disappeared. Conservation *in situ* should require two conservation operations first: removal and transfer to a new and appropriate support; protection against the weather and against biological damage.

M. Ennaifer: From the cultural point of view, moving a mosaic from its site is regrettable.

M. Bassier: Either you remove the mosaics to preserve them, or they're lost.

M. Ennaifer: I would like to be optimistic and I hope that some future method will resolve this problem.

Sig. Robotti: From the different points of view expressed during this discussion, it's clear that a new approach to problems of mosaic preservation is needed. This approach should be based, above all, on control of the environment and on the definition of the most efficient means of treating mosaics, so as to guarantee the survival of our civilization.

THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION
PUBLISHED WEEKLY

Volume 100, No. 1, January 1958
Chicago, Ill., U.S.A.

[Faint, illegible text in the left column, likely bleed-through from the reverse side of the page.]

[Faint, illegible text in the right column, likely bleed-through from the reverse side of the page.]

THE RESTORATION AND CONSERVATION OF MOSAICS IN TUNISIA

by Mongi Ennaifer

Translated from the French
by Patricia Bonicatti

The Importance of mosaic collections

Tunisia possesses the most remarkable mosaic collection in the world today. Its wealth in this field greatly surpasses its means of conservation. The National Institute of Archaeology and Arts (I.N.A.A.) makes every effort to develop the study, the restoration and the appreciation of these pictorial documents. For this purpose, the Institute has undertaken the long and difficult task of compiling the Corpus of Mosaics in Tunisia. A first volume in three parts, devoted to the region of Utica, has already been published. The mosaics which have been preserved and studied only represent a small percentage of those excavated during the course of the last century, and of those continuing to be discovered. The spread of urban development, mechanized agriculture and industrial plants is providing countless discoveries. Thus, the Institute must intervene without delay and throughout the country. The scarcity of qualified personnel, the lack of appropriate equipment, the climatic conditions (the humidity level being generally high), erosion and the fragility of the mosaic pavements are all factors which contribute to the loss of these often unrecorded art works.

Method of conservation

Tunisia continues to use the method of laying the pavements on a support of reinforced concrete or plaster. It is true that this system presents certain problems. But the laying of the pavements, being done in workshops and their destination being usually a museum, therefore secure from bad weather conditions, the problems engendered by reinforced concrete stands are somewhat reduced. We are, however, in favour of the use of synthetic resins. Our recent attempts at creating a stratified "sandwich"

reinforced by layers of fibreglass have been rather successful. Our main problem in using this effective method is the difficulty of importing fibreglass.

Restoration

In the field of restoration we are trying equally hard to improve our techniques, which are still at a handicraft level. Our concern is to protect the homogeneity of the work, intervening cautiously, both with mosaics remaining *in situ* and those preserved in museums. At Thuburbo-Majus, where the work on the Corpus of the Mosaics of Tunisia is currently going on, we tried to fill in the important lacunae by using a lime mortar of cement and sand, inlaid with polychrome pebbles. This method has been used elsewhere, notably in Algeria, but is not well proved yet. In the field of museum exhibits, we have recently eliminated a good number of the old "restitutions". Their colours were far from adequate, and the restitutions of the chronology and of the scenes were sometimes inexact and even fantasied. One example is the case of a doorstep of a house at El-Jem with a pattern of five rings decorated by a fish, crowned by the digit "5". As the rings were mistaken for a part of the frame, the restorer thought it was logical to continue them. He did not establish the connection between the digit "5" and the sodality of the Pentasii. This poor restitution is not unfortunately an isolated case. Thus, one should only reconstitute the motifs of which one is absolutely sure and should complete them as much as possible in the same tones as the mosaic. When important lacunae are involved it is sometimes useful to unobtrusively suggest the composition lines to facilitate comprehension by the public.

THE ACTIVITIES OF THE DEPARTMENT OF ANTIQUITIES OF THE HASHEMITE KINGDOM OF JORDAN

by Mohammed Ghouj

Original text in English

On behalf of the Department of Antiquities of the Hashemite Kingdom of Jordan and the Director of Antiquities, Dr. Adnan Hadidi, I wish to express my gratitude for being invited to participate in this very important international conference. I especially would like to thank the Director of the ICCROM Centre, as well as its members.

As you know, Jordan is located in the geographic centre of the Arab world. It contains some of the most ancient archaeological sites in the world - from the beginning of civilization, such as the neolithic city of Jericho, to the flowering of ancient cultures in such sites as Nabatean Petra, Roman Jerash, Byzantine Madaba and Islamic Jerusalem, with its Dome of the Rock, as well as the Islamic castles in the Jordanian desert.

Our conference today deals above all with the preservation of mosaic art. It gives me great pleasure to be able to return to ICCROM as a representative of the Department of Antiquities of Jordan, for I first studied mosaic preservation in Italy, in Rome and Ravenna in 1964. Since returning to Amman, I have been engaged in the restoration of all mosaics discovered in Jordan. I would like to say a word about the activities of the Jordanian government in the field of mosaics.

There are three outstanding examples of mosaic art in Jordan. The first is the incomparably beautiful and important Madaba map of Palestine, Jordan, Sinai and parts of Egypt. The second is the Mukhayat mosaic pavement; and the third is the Tree of Life and Bath Hall pavements at Hisham's Ommayyad Palace in Jericho. All of the above mosaics have been kept in their original locations because the land has been purchased by the Jordanian government.

Three mosaics, the Madaba map, the Mukhayat and Mount Nebo pavements are under the protection of Christian religious groups. The government has been most active in purchasing

properties containing mosaics in order to preserve them for posterity. For example, four private houses containing mosaics were purchased in Madaba alone.

Funds for the development of the conservation programme and the training of young mosaic experts must be raised in order to solve Jordan's immediate problems. One of our most pressing needs is for scholarships to allow promising candidates in mosaic studies to pursue their research. These scholarships would ensure our country specialists of its own in this important archaeological field. In addition, young Jordanian students would have the opportunity to learn the latest techniques of mosaic conservation.

The familiar method of gluing mosaics and using cement and steel frames for transporting them leaves much to be desired. We in Jordan are very much in need of assistance and information in these matters. The Antiquities Department has recognized the fact that our country is very rich in mosaics.

Jordan has the rare honour of having two museums for mosaics. The larger of the two collections is in the Roman theatre in Amman, which has been designed to display and preserve individual mosaics discovered throughout the kingdom. The second museum, located in Jerash, contains Roman and Byzantine mosaics exclusively. A new wing of the museum at Madaba will soon contain mosaics which are frequently uncovered during building and road construction.

I have tried to present briefly to you some of the recent activities in which the Department of Antiquities has been engaged and to describe a few of the ways in which ICCROM might assist us in furthering the development of this important branch of conservation. We would be grateful for any further help that you might be able to provide.

As we say in Arabic, "shrukran jazeelan" - thank you very much.

THE TREATMENT OF MOSAIC PAVEMENTS IN SYRIA SINCE 1939

by Raif Hafez

Translated from the French
by Patricia Bonicatti

Syria is one of the world's richest repositories of ancient mosaics. I would like briefly to tell you about the method of detachment and restoration of floor mosaics used in Syria since 1939.

Lifting

1. Clear away the debris, reinforce the lacunae and weak edges with mortar.

2. Clean the mosaic pavement with water, using brushes, spatulas and pointed tools. Sometimes a bed of lime and earth accumulates on the surface of the pavement. In this case, the surface must be cleaned with hydrochloric acid diluted with water. The cleaning must be adequate. It can be done in the most convenient way.

3. Photograph the mosaic pavement, its site, and the details of the panels.

4. Draw a general site plan as well as a detailed plan of the mosaic panels. Then cut the mosaic pavement into panels (Fig. 1).

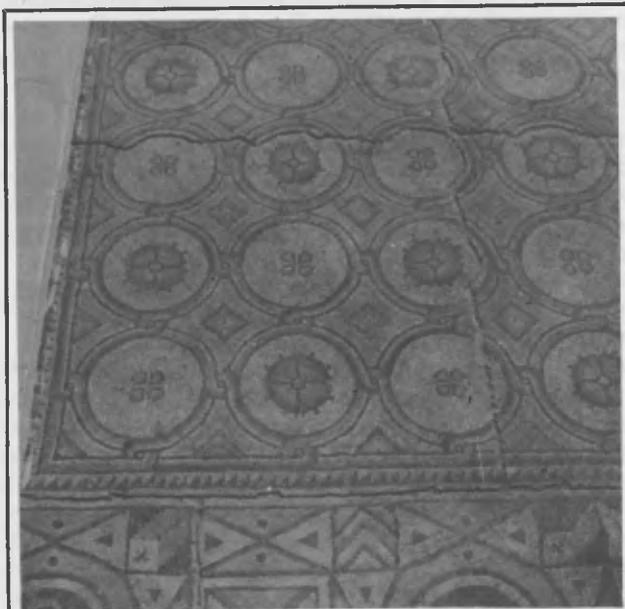


Fig. 1 - Mosaic pavement cut into panels to allow its removal

5. The size of the panels should be decided according to necessity but should not exceed 220×180 cm.

6. Wash the binding cloth, cut it into the sizes needed, and then roll it up.

7. Spread white synthetic glue on the surface of the panels (approximately $1/2$ m², depending on the width of the cloth. Lay the cloth down on the glued surface and slap it with brushes to increase adhesion (Fig. 2).

8. When the glue dries, cut the pavement attached to the cloth along the previously established cutting lines. Identify the fragments and the mosaic panels with letters and numbers according to the plan.



Fig. 2 - Gluing cloth to the face of the mosaic in order to hold tesserae in place during the process of lifting



Fig. 3 - A cement mortar is applied over the metal framework attached to the back of the mosaic

9. Probe under the panels with long chisels in order to separate the pavement from the earth. Sandwich the panel in a wooden frame and then turn it upside-down.

10. Pack as many panels into crates as possible and transport them to the workshop.

Restoration

One can summarize the restoration work as follows:

1. Remove the old cement with pointed tools and chisels.

2. Lay out the panels, face down, on the ground according to the original plan.

3. On top of the panels, lay a wire mesh reinforced with six 10 mm diameter steel bars, according to the dimensions of the panels.

4. Fine metal or wooden strips should be placed between the panels in order to contain the wet cement.

5. The back of the mosaic is then moistened with water and covered with a mixture in the following proportions: cement 1, gravel 1, sand 2 (Fig. 3).

6. After everything is dry, lift up the panels and turn them face up. Detach the cloth from the pavement surface. Clean the pavement and wash it with water. Now the mosaic is ready to be displayed in the desired location.

7. In the chosen location, lay the panels side by side according to the original plan, either on the ground or on a wall (where they would be attached with small metal hooks).

8. All lacunae should be filled with appropriately coloured tesserae of similar size.

THE MOSAIC OF "THE GOOD SHEPHERD"

by Jeronimo Escalera Urena

Original text in English

(The author did not furnish illustrations).

I have the honour of presenting to you an illustration of the reconstruction of a 5th century A.D. pavement fragment, discovered in 1890 in Montecillas, Huesca, Spain. This work was carried out by the Instituto de Conservacion y Restauracion de Obras de Arte in Madrid.

First the figure identified as "The Good Shepherd" was studied, as well as the related inscription. By means of several letters still visible, we reconstructed the word "adornavit".

In the slides, we can see:

The damaged areas of the mosaic before work began.

Preparatory drawings for the reconstruction of the figure.

Preparation of the supporting panel with the use of Araldite.

Resin is added.

View of the fibreglass.

Rolling the mosaic, the tesserae become attached to the support.

The figure was reconstructed with tesserae found *in situ*. The border was finished with detached fragments from the original work. For the letters of the inscription "adornavit", and for the blue and green background, we used tes-

serae of a plastic material coloured with special mineral pigments. These tesserae were used to obtain colours which would most closely blend with the original tesserae.

The finished panel. Lacunae in the figure were filled with a drawing

At present, the panel with its wooden frame is on display in the Archaeological Museum of Huesca.

DISCUSSION

M. Bassier: Can you tell us how you made synthetic tesserae?

Sr. Escalera Urena: We have several synthetic elements. After experimenting with various materials, we have tried to use them in such a way that you can tell they are modern. The mosaic pieces are made of Araldite, mixed with pigment in the mould. It is easy to create a wide range of colours similar to those found in Venice or Rome. I think it's interesting because it is hard to find materials resembling the original ones. Synthetic substances seem different, warmer to the touch of the hand.

THE TREATMENT OF SOME MOSAICS IN ENGLAND

by William E. Novis

Original text in English

I have been for twenty years the managing director of a company in London which has been concerned with Roman mosaic pavements for over sixty years and I have been responsible for this work for the last twelve years. We have also been engaged in the design and making of many types of modern glass mosaics but that is outside the scope of today's report.

I would like to show you a number of examples of practical work going on at various sites and in the workshop. Please make a note of anything which you consider good or bad so that at the end of this talk you may say so for the benefit of everyone present, including myself.

The first example is of work at the Roman palace of Fishbourne. First, lifting and relaying geometric mosaics, noting the grid lines on the surface of the scrim in order that the mosaic may be correctly relaid (Fig. 1). Then joining up

sections of mosaic that had been lifted hurriedly when the site was discovered (Fig. 2). Then relaying an undulating mosaic in order to preserve the contours caused by the subsidence of the floor into the post-holes of an earlier building on this part of the site (Figs. 3, 4).



Fig. 1 - Roman palace, Fishbourne
Geometric patterned mosaic partly lifted. Note the grid reference battens, the grid lines marked on the surface scrim. Mosaic already lifted and reversed in the foreground



Fig. 2 - Roman palace, Fishbourne
Geometric patterned mosaic being relaid. Note the grid lines being located to line across pavement from surrounding reference battens



Fig. 3 - Roman palace, Fishbourne
Undulating mosaic relaid to contours resulting from collapse of substrata into post-holes of earlier timber building

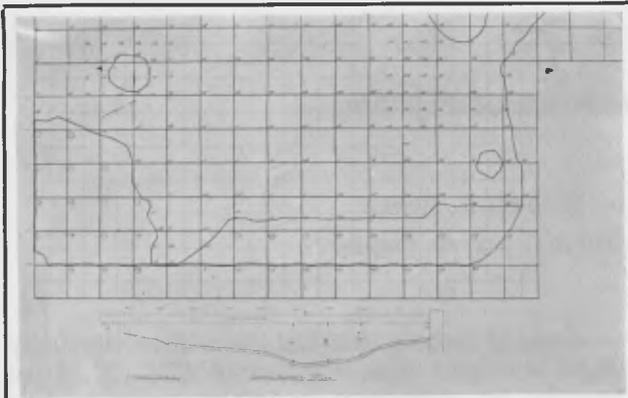


Fig. 4 - Roman palace, Fishbourne
Drawing recording undulations from a level datum taken before conservation. The mosaic was then lifted, a new base laid to the recorded shape, and the mosaic relaid. In the areas of acute distortion, measurements were taken at closer intervals

We also lifted the Hinton St. Mary pavement, now in The British Museum (Fig. 5). You will note the pieces of scrim and Hessian around the outside border. These were particularly necessary as some earlier studies had been lost and it was essential to test various glues and fabrics to ensure a safe procedure.



Fig. 5 - Hinton St. Mary, Dorset
Illustration shows organization of lifting mosaic, including surrounding grid-reference batters, scrim fixed over mosaic face, prepared drawing of pavement on which to record sections lifted and numbered, lifted sections reversed and laid in specially-made trays for cleaning, storing and transportation

We also lifted a pavement at Cirencester, the old city of Corinium (Fig. 6). The site was particularly damp (Fig. 7).

We carried out a difficult lifting operation in Beadlam in Yorkshire on behalf of the Department of the Environment. This difficulty was caused by the use, when the mosaic was laid, of a limestone mortar which was extremely hard



Fig. 6 - Hare Pavement, Cirencester
Lifting of mosaic. A sheet of panel board is inserted below section being lifted. Note the portable gas burner and supply cylinder for drying out on damp site



Fig. 7 - Hare Pavement, Cirencester
Central motif section being slid carefully onto panel board for safe handling, reversing and cleaning. Note grid lines in both directions.



Fig. 8 - The Great Pavement, Woodchester. The surface has been covered with scrim following the pattern lines. A section has been cut out and lifted. The nucleus has been detached, disclosing a fracture in the base

and thick. The paving had collapsed into the hypocaust. No mosaic was found in the trench so it must have fallen in while the villa was still occupied.

The Sea God mosaic from Carthage was also rebaked for display in The British Museum. The original panel was very heavy, about 180 mm thick. The new panel is about 80 mm thick and one-quarter the weight. The back of the mosaic was cleaned after the old backing was removed, then "doped" with epoxy resin. An aluminium frame was prepared and bedded onto the back of the mosaic. The spaces in the frame which were spanned by reinforcement net were then

filled in with a mixture of epoxy resin and vermiculite, thus forming an extremely strong but light panel.

The last example is of the Great Pavement of Woodchester and shows how certain repairs were carried out when the pavement was uncovered a few years ago. It is exposed every ten years. The old mortar in these sections was removed and a new bed used to refix areas which had become unsound (Fig. 8).

I welcome comments on these activities and I am willing to answer questions to further explain any details.

THE TREATMENT OF MOSAICS AT CARTHAGE

by Amy Rosenberg

Original text in English

(No illustrations were furnished with this paper).

In the Summer of 1975, the University of Michigan began its current campaign of excavations at Carthage, Tunisia. Subsequent seasons were in 1976 and 1977. The existence of previously excavated mosaic panels influenced the choice of site and we began excavating with the expectation of uncovering, documenting and lifting mosaics. The Tunisians had given us permission to lift mosaics on condition that we finally replace them on the site in an archaeological park setting. Almost all the mosaics were floors found in different phases of a peristyle house which was occupied between the late 4th and middle 6th centuries A.D. Two other fragments, were found elsewhere on the site.

The pavements I wish to discuss here were all uncovered in the peristyle house during the 1975 season with one exception, the fish mosaic found during 1977.

Directly beneath the modern turf lay an *opus sectile* floor of the 6th century, approximately 12 metres by 12 metres, pieces of which were visible through the grass. This slide shows an aerial view of the *opus sectile* after cleaning. Note the high quality of the work despite its fragmented state. The marble pieces were mainly in sound condition and in their proper arrangement. The exposure of the pavement to weathering, pedestrian traffic, and the growth of vegetation, had caused the decay and deposition of the mortar and shattering of several of the pieces. This had also caused the deterioration of two varieties of marble which had become sugary - a green one, possibly *verde antico*, and a white one.

Our first task was to clean and lift the pavement in order to carry on the excavation of the house. These next two slides show the cleaning process. This consisted of removing the grass and weeds by hand, as can be seen in the slide on the left. All the marble pieces and the intervening spaces were then carefully cleaned and brushed. This is shown in the slide on the right. It was decided to lift the pavement in sections by the so-called carpet method, which was not

difficult because the marble pieces were loosely held in the bedding. This method of lifting is described in detail by W.E. Novis in a paper delivered at the 1975 Stockholm Congress of the International Institute for Conservation. First the pavement is thoroughly cleaned and dried. The next two slides show the next steps in the process. The surface of the stones is painted with polyvinyl acetate emulsion as can be seen on the left; when this is dry, a layer of textile is glued down with the PVA as is shown on the right. When this is dry, the sections are loosened from the bedding with trowels. The stones adhering to the facing material are gradually lifted onto a board, covered by another board in a sandwich, turned over and carried to a workroom or storage.

Mr. Novis speaks of lifting mosaics in a cool, wet climate. We were working in the hot dry summer of North Africa. In this situation, the best drying of the adhesive and formation of the facing occurred in late afternoon or early morning after the dew evaporated, when the temperature was not too high. In warm conditions, a skin would form quickly over the material and inhibit drying. The stones must also be thoroughly cleaned of dust to effect the best adherence of the PVA. Light dust accumulated on the dry adhesive should be brushed off. We also found it necessary to store the pavements flat, since the PVA of the facing became soft in the heat with the consequence that the marble pieces tended to move by their own weight.

Directly beneath the *opus sectile* was a bedding consisting of body sherds of amphorae, broken lengthwise. This is shown in the slide on the left. The sherds are in a fine grey mortar nucleus beneath which were five centimetres of a lumpy rudus. The rudus is characterized by the inclusion of tesserae and larger fragments from a mosaic beneath it which had been broken up and mixed with the mortar. Fragments of the border of the earlier mosaic and long narrow strips corresponding to edges of the panels of *opus sectile* remained *in situ*. The bedding of the *opus sectile* was removed and the lower mosaic was revealed; this became known as the

acanthus mosaic. The slide on the right, a view from the east, shows most of the acanthus mosaic after cleaning. The borders of the mosaic in the slide on the right were beneath the bedding in the slide on the left at the point which I indicate. The existing strips of mosaic in the slide on the right correspond to these lines in the slide on the left. The threshold in the slide on the left remains *in situ* in the slide on the right.

The lifting of the mosaic was accomplished by the carpet method in the existing strips and sections. The problem of cleaning was twofold. First, most of the floor had to be cleaned gently and carefully in order to uncover the tesserae which were still in their original arrangement and leave the remaining disturbed tesserae in their places with the hope of obtaining an idea of the former arrangement. On the other hand, the existing areas of the border were covered by a very hard, compact grey mortar which obscured the pattern and colours of the tesserae. These areas needed more radical treatment.

The next slide on the left is a detail of a strip surrounded by the disturbed tesserae mixed with the mortar, after cleaning. The position of the mixed tesserae made it necessary to go extremely slowly using dental tools and soft brushes. In other places, the arrangement of eight or ten tesserae was only apparent after this cleaning. An area of the border which was covered with mortar is shown on the right. Notice how the tesserae are obscured and adhering together. These areas were cleaned with various abrasives and instruments. Scalpels, dental tools, and knives were effective in places. For larger areas, the Tunisian workmen suggested two methods which were tried. The first was to rub the area of the mortar with lumps of the local Amilcar sandstone, a coarse, loosely packed rock which acted like sandpaper and wore down with use. We used it both wet and dry. The other suggested method was rubbing with wet beach sand. Our success with these was limited. We then tried steel brushes, steel wool, and hammer and wood chisels. With practice, the hammer and chisel would pop off the mortar leaving the tesserae clean and separated

from each other, sometimes in blocks. Since this technique is quite drastic, it was used to determine the colours only. The single uncovered tesserae in the slide on the right were cleaned this way. The combined abrasive techniques served to clean the sections well enough so that they could be lifted. The PVA adhered well to the mortar.

The last pavement which I will discuss was uncovered during the 1977 season in the peri-style house. It is shown in these two slides - the one on the left illustrates its present situation between excavated areas. Its fragmented state is clearly visible as is its precarious situation. The mosaic appeared early in the season. Scientific excavation techniques which demand accurate recovery of information dictated the treatment of the mosaic. Later intrusive robbing pits - where early walls had been - were excavated first, since this procedure is necessary for accurate dating. At the end of the season, the mosaic was left standing up on an island of stratified material which represents a series of occupation levels which will be excavated in 1978. One was faced with a dilemma. Either (1) leave the exposed, uncleaned mosaic *in situ* over the winter and risk its deterioration, or (2) clean and lift the mosaic and risk losing some archaeological evidence for its dating, or (3) clean and document the mosaic, consolidate the surface, and put a layer of earth over it. Since a watchman guards the site during the winter, and since we had been successful with a similar treatment in 1976, we chose the last option. First the surface of the mosaic was cleaned. It was coated with a tough, compact layer of calcareous soil which yielded only to scraping with a scalpel or scrubbing with steel wool. After thorough documentation, the surface was coated with two layers of polyvinyl acetate emulsion and covered with a layer of earth which will be renewed as it weathers.

I have presented the three most important mosaic finds of the current University of Michigan excavation at Carthage, the problems of conservation which they raised and some solutions. I hope more light can be thrown on such problems by a sharing of information at a gathering of this sort.

ON THE NEED TO TRAIN MOSAIC RESTORERS

by **Ciro Robotti**

Translated from the French

"Beginning now, a school of restoration must be established to train skilled craftsmen to whom one can entrust mosaics without fear that they will be harmed".

This statement - unfortunately still valid today because nothing has changed - is by Giovanni Battista Cavalcaselle. It is taken from the memorandum letter of 1862 that he addressed to Matteucci, the Minister of Education of the time. In 1863 it was published under the title "On the Preservation of Monuments and Works of Art and the Reform of Academic Teaching".

It was first reprinted in Florence in 1870 in a version consisting of the essential chapters with the addition of some later observations and an introduction by Francesco Dall'Ongaro. A complete edition was republished in Rome in 1875.

Chapter 14 is devoted to "methods of training mosaic restorers". In it, Cavalcaselle wrote: "Before touching a mosaic, the future restorer should have a perfect knowledge of ancient techniques".

Reconstruction of an original work in fact requires a profound knowledge of the old techniques used to express different tastes. From antiquity to the 19th century, the history of mosaic art shows a remarkable complexity of aesthetic expression. He adds later:

"Whenever the restorer has to work on a mosaic he, or another skilled artist, should make a copy of it, that is, a facsimile, containing also its lacunae. The restorer should then fill the lacunae, in the imitation mosaic, as he would in the original. In this way, the restorer will show that he knows the style, the character and the technique of the work which he intends to restore. Furthermore, this way of working will soon provide a collection of examples of mosaic techniques of all periods and schools. Arranged in historical and chronological order, these facsimiles would make up the teaching material of the school. A professor could give lessons directly from the mosaics or the facsimiles. These courses would be printed, in order to serve as references for the student. Students would be required to make coloured

copies of these models. Later, they would work on actual mosaics, copying the various ways of working in antiquity".

Cavalcaselle thus maintains that manual work carried out in the studio (after the close study and copying of examples from different periods) is a necessary prerequisite to the acquisition of a deep knowledge of mosaics.

For Cavalcaselle, the most important exercises for the student were preparing the cartoon and transposing it in the place where the mosaic will be set; spreading the setting bed; preparing, placing and orienting the tesserae.

"Whenever a teacher restores a mosaic, the students should climb up on the scaffolding to study the original and to see how the master works. Where the best examples of mosaics of different periods and schools are found, mobile scaffolds should be built so that students may study the works at close range. Students should also be concerned with the preparation of the materials needed in their craft, such as colours, vitreous pastes, polishes, etc. The school should have a laboratory in which a professor of chemistry would give a course of applied chemistry relative to mosaics".

Finally, Cavalcaselle points out the need to know the elements of which a mosaic is made: mortar, marble and stones, vitreous pastes, sinopie. These are necessary to a diagnosis in cases of deterioration. They are the basis of appropriate interventions whether for conservation or restoration. Yet mosaics, judging by the materials of which they are composed, seem almost indestructible. In fact, they often are attacked by vibrations from traffic, wearing by pedestrians, humidity, plants and micro-organisms, the aging of supports, atmospheric pollution which slowly but progressively produces grave damage.

These destructive factors cannot be studied by traditional methods. Modern research methods must be used, based on physics, chemistry, etc. By determining the reasons for the losses, it will be possible to fight against them in the future.

Modern instruction should include training in



Museum, Ostia: Marble bas-relief showing craftsmen cutting tesserae

the history and connoisseurship of mosaics, knowledge of the fundamental principles found in the international restoration agreements, a scientific knowledge of the causes of deterioration, and a systematic way of working. Also to be sought is manual dexterity through direct and constant contact with the material. It should be remembered that since antiquity apprentices were in the workshops and learned their craft by working directly with their masters. Thus they learned to recognize the particular type of surface a mosaic requires and how to restore mosaics which have need of restoration.

Cavalcaselle's recommendations are strikingly relevant today when discussions on the subject are being held in Italy and in other European countries under the auspices of international organizations.

Here we would like to express the wish that this assembly would propose the prompt establishment of schools for mosaic restorers and would recommend a very specific discipline, in both history and technique. In Italy, the problem of training restorers has been the subject of continual discussion since the national assembly, "A Future for Restoration", which was held

from the 23rd to the 26th of September 1976 in Naples and Ravello. In the group "Arts and Crafts in Restoration", the problem of preserving architectural properties (marble decorations, plaster, wood, etc.) was particularly discussed. The final resolution of the meeting states that their preservation depends on the recognition of "the lack of restoration technicians trained in the rigorous scientific methods of this profession".

What is needed is a change in mentality. This must begin at the primary or secondary level of education in which, up to today, everything is geared toward creation and nothing toward conservation.

Concluding this brief address in a field in which Viollet-le-Duc, Ruskin, Cavalcaselle, Boito and Beltrami - to name only some of the greatest theoreticians and practitioners - have distinguished themselves, we would like to express the wish that a course for mosaic technicians be established as rapidly as possible. It's a vast and complicated area which needs not only the commitment of a qualified team of professors and experts but also adequate funding from the government.

ESTABLISHMENT OF AN INTERNATIONAL COMMITTEE FOR THE CONSERVATION OF MOSAICS

In order to continue the work which has begun with the First International Symposium on the Conservation of Mosaics, a Committee has been formed. The members of the Board are the following:

The Director of ICCROM (ex officio) or his representatives
Henri Lavagne or a representative of AIEMA (ex officio)
Irina Andreescu
Claude Bassier
Mongi Ennaifer
Lawrence Májewski
Paolo Mora
William E. Novis
Maria Luisa Veloccia
Alberto Villa
Rolf Wihr.

ICOM, ICOMOS and IIC will be invited to send observers.

The Committee will work in contact with the International Association for the Study of Antique Mosaics (AIEMA) and will seek to determine areas of cooperation with the Association.

Collaboration with UNESCO, ICOM, ICOMOS and IIC will be investigated. Dr. Feilden will discuss possibilities with the organizations, with the particular goal of sharing information and coordinating projects.

ICCROM has agreed to serve as the Committee's Secretariat until November 1978.

Paolo Mora has been elected President of the Board.

The Committee has decided on the following goals:

1. Publication, in French and English, of the proceedings of the Symposium.
2. Collection of suggestions for a future course on the conservation of mosaics with the view to establishing a program.
3. Establishment of an annual directory of people working on the conservation of mosaics.
4. Recommendation, when a mosaic is going to be detached, that a complete cross-section (statumen, rudus, nucleus, and tesserae) be preserved.
5. Encouragement of the documentation of specific cases of destruction, salvage, and restoration.

A second meeting of the Board took place from 6-8 July 1978 at Tunis and Carthage at the invitation of the Institut national tunisien d'art et d'archéologie. During the meeting, the questions involved in the safeguard of mosaic were studied. The advantages of different supports were also compared. The proceedings of the meeting will be published under the title: Mosaics, No. 2, Safeguard.

PRESS RELEASE

At the end of the meeting, the Secretariat sent to the principal Italian newspapers, and to the news services, the following press release in English, French and Italian:

Fifty specialists from sixteen countries have met in Rome to discuss the conservation of mosaics in the countries of the ancient Roman empire.

They are concerned about the great dangers pavement mosaics are suffering from the damaging effects of new construction, excavation, and engineering projects. They also want to emphasize that wall mosaics are endangered as well by pollution and by the decay of the walls behind them.

These dangers are even more acute because few specialists are capable of conducting projects to conserve, consolidate and restore mosaics.

Besides, laws protecting a country's cultural patrimony are not always applied and, in certain countries, more than 50% of the mosaics are destroyed upon discovery.

As a result, the meeting decided:

To awaken responsible agencies and persons to the dangers threatening mosaics.

To form an International Committee for the Conservation of Mosaics with the Secretariat at ICCROM.

To create a course for technicians responsible for the conservation of mosaics.

Sixteen countries were represented: Algeria, Belgium, Bulgaria, Cyprus, England, France, Holland, Israel, Italy, Jordan, Spain, Tunisia, United States, Vatican City, West Germany, Yugoslavia.

This first symposium was held from 2 to 5 November 1977 at the International Centre for the Study of the Preservation and the Restoration of Cultural Property (ICCROM), 13 Via di San Michele, 00153 Rome. Telephones: 58-94-741 / 58-09-021.



CONTENTS

INTRODUCTION

- P. 3** Acknowledgments
5 Foreword Bernard M. Feilden
6 Sources of illustrations
7 List of participants
13 Glossary

OFFICIAL PAPERS

- P. 15** The Conservation of Pavement Mosaics Before Modern Times: A Selection from the Mosaics of Gaul Henri Lavagne
20 The Wall Mosaic: History of Restoration, Evolution of Techniques Irina Andreescu
37 Discussion
39 Conservation Problems of Mosaics in Situ Maria Luisa Veloccia
46 Discussion
47 Some Experiments in the Use of Epoxy Resins for the Impregnation of the Nucleus Giuseppe Marinelli
49 The Removal of Weeds from Outdoor Mosaic Surfaces Alberto Villa
52 Discussion
54 The Cleaning, Consolidation and Treatment of Wall Mosaics Lawrence Majewski
61 Discussion
62 The Restoration of Mosaics in Germany Rolf Wihr
67 Some Problems in the Conservation of Mosaics Claude Bassier
78 Appendix
81 Discussion
83 The Problem of Lacunae in Mosaics Paul Philippot

ADDITIONAL PAPERS

- P. 90** The Restoration and Conservation of Mosaics in Tunisia Mongi Ennaifer
91 The Activities of the Department of Antiquities of the Hashemite Kingdom of Jordan Mohammed Ghoul
92 The Treatment of Mosaic Pavements in Syria since 1939 Raif Hafez
94 The Mosaic of « The Good Shepherd » Jeronimo Escalera Urena
95 The Treatment of Some Mosaics in England William E. Novis
98 The Treatment of Mosaics at Carthage Amy Rosenberg
100 On the Need to Train Mosaic Restorers Ciro Robotti

FOLLOW-UP OF THE MEETING

- P. 102** Establishment of an International Committee for the Conservation of Mosaics
103 Press release

INTERNATIONAL CENTRE FOR THE STUDY OF THE PRESERVATION AND THE RESTORATION OF CULTURAL PROPERTY

